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CARLSBAD RESOURCE AREA

August, 1992

DRAFT

DARK CANYON

ENVIRONMENTAL IMPACT STATEMENT

NOTICE

THIS DRAFT ENVIRONMENTAL IMPACT STATEMENT (EIS) SHOULD BE RETAINED TO BE USED IN CONJUNCTION WITH THE FINAL EIS. IF CHANGES RESULTING FROM PUBLIC REVIEW AND COMMENT ON THE DRAFT EIS ARE RELATIVELY MINOR, THE FINAL EIS WILL NOT REPRODUCE THE DRAFT TEXT IN FULL: HOWEVER, THE FINAL EIS WILL INCLUDE THE MODIFICATIONS AND CORRECTIONS WHICH SHOULD BE MADE TO THE DRAFT TEXT AS A RESULT OF PUBLIC REVIEW AND COMMENT. AS WELL AS A RECORD OF PUBLIC COMMENTS ON THIS DRAFT AND THE RESPONSES TO THOSE COMMENTS.

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BUREAU OF LAND MANAGEMENT
New Mexico State Office
1474 Rodeo Rd.
P.O. Box 27115
Santa Fe, New Mexico 87502-7115

IN REPLY REFER TO:
1793/3160.1(920)

August 31, 1992

Dear Reader:

Enclosed for your review and comment is the Draft Dark Canyon Environmental Impact Statement (EIS). This document describes and analyzes the proposal by Yates Energy Corporation to drill the Diamondback Federal No. 1 well on federal lease NM-62161 in T.24S, R.24E, Section 19, NE 1/4, SE 1/4 NMPM, in Eddy County, New Mexico. This document also analyzes the reasonable forseeable development for the EIS study area and four alternatives to the proposed action, including the no action alternative.

As this proposal is near the northern boundary of Carlsbad Caverns National Park (CCNP), managed by the National Park Service (NPS) and is geographically close to Lechuguilla Cave, NPS is a formal cooperating agency for this project.

The purpose of this review of the draft EIS is to improve the impact analysis and the decision-making process. We welcome your comments. Written comments should be addressed to:

Joe Incardine
Bureau of Land Management,
New Mexico State Office (NM-911)
P.O. Box 27115
Santa Fe, NM 87502-0115 [Telephone: (505) 438-7458]

All written comments must be received by no later than NOV 20, 1992 in order to be considered in the Final EIS. Comments on the Draft EIS may be submitted in writing or presented orally during the public hearing on this proposal. The hearing is scheduled as follows:

Date	Time	City	Location
OCT 22 1992	7:00- 9:00 pm	Carlsbad, New Mexico	Hotel Stevens, 1829 S. Canal St.

A one-hour informal open house will be held immediately prior to the public hearing from 6:00-7:00 pm. A 10-minute time limit will be placed on oral comments. Oral comments should be accompanied by a written synopsis of the presentation. Written and oral comments will be fully evaluated and considered in the preparation of the Final EIS.

Sincerely,

Larry L. Woodard
State Director, New Mexico

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U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

DRAFT
DARK CANYON ENVIRONMENTAL IMPACT STATEMENT

ABSTRACT

The Applicant, Yates Energy Corporation, has submitted an Application for Permit to Drill (APD) the Diamondback Federal No. 1 well on federal lease NM-62161 in T.24S, R.24E, Section 19, NE 1/4, SE 1/4, NMPM, in Eddy County, New Mexico. The location lies within the BLM-designated Dark Canyon Special Management Area (SMA) and is near the northern boundary of Carlsbad Caverns National Park (CCNP) managed by the National Park Service (NPS), a cooperating agency for the preparation of this EIS. Because of the potential impacts of this proposal and of the reasonable forseeable oil and gas development of this area on cave resources, hydrology and other natural resources, the Bureau of Land Management decided to prepare an Environmental Impact Statement (EIS). This EIS analyzes the potential environmental impacts of this action and four alternatives; BLM has selected Alternative C, (Relocate the Diamondback Federal No. 1 Well Pad, using Enhanced Precautionary Operations for the entire EIS Study Area) as the agency's preferred alternative.

Type of Action: (X) Administrative ( ) Legislative

Contact For This EIS:
Joe Incardine
Bureau of Land Management
New Mexico State Office (NM-911)
P.O. Box 27115
Santa Fe, NM 87502-0115 [Telephone: (505) 438-7458]

Cooperating Agency: National Park Service, Southwest Region and Carlsbad Caverns National Park

Date Filed With EPA: Draft: SEP 18 1992
Final: ______

Dates of Comment/Review Period:
From: SEP 18 1992
To: NOV 20 1992

Larry L. Woodard
State Director, New Mexico

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SUMMARY

SUMMARY

The Bureau of Land Management (BLM) is preparing an Environmental Impact Statement (EIS) on the impacts from reasonable foreseeable development (RFD) of oil and gas resources within Dark Canyon, located in Eddy County, New Mexico. This study includes analysis of Yates Energy Corporation's Application for Permit to Drill (APD) the Diamondback Federal No. 1 well on federal lease NM-62161 (see Appendix G).

The Dark Canyon EIS study area encompasses approximately 8,320 acres and lies about 10 miles southwest of the City of Carlsbad. The EIS study area is in the BLM's Carlsbad Resource Area and totally encompasses the Dark Canyon Special Management Area (SMA), noted for its rugged and scenic landscape and cave resources (see Maps 1-1, 1-2, and 1-3).

The intent of the EIS is to provide a full discussion of all significant impacts and cumulative effects that may result from full field development. It will inform the decisionmaker (the BLM New Mexico State Director) and the public of reasonable alternatives that would avoid or minimize adverse impacts or enhance the quality of the human environment.

The BLM is the lead agency for this EIS, since the Bureau is responsible for permitting oil and gas exploration on federal mineral estate. The National Park Service (NPS) is a cooperating agency because the study area borders Carlsbad Caverns National Park (CCNP) to the south which includes Lechuguilla Cave.

The two major resources identified as potentially being impacted are BLM and NPS administered caves, especially Lechuguilla Cave on adjacent NPS lands, and the Capitan aquifer, which supplies drinking water to the City of Carlsbad. The Dark Canyon EIS analyzes five alternatives in order that management concerns and the issues raised during scoping may be addressed for drilling and producing oil and gas resources. The alternatives to the proposed action incorporate management prescriptions for the proposed Diamondback Federal #1 well and other foreseeable wells, which specifically protect cave resources through avoidance and mitigation.

The five alternatives developed for the EIS are summarized below and further described in Chapter 2. The impacts anticipated from these alternatives are described in Chapter 4, with a summary of impacts on Table S-1, following this text.

ALTERNATIVE A: THE PROPOSED ACTION AND CONVENTIONAL DRILLING OF WELLS WITHIN THE EIS STUDY AREA

Under Alternative A, the Application for Permit to Drill (APD) the Diamondback Federal #1 well would be approved virtually as submitted by Yates Energy Corporation. The reasonable foreseeable development scenario (RFD) would include approximately 8 wells within the EIS study area. Because only one of the RFD leases was issued subsequent to the RMP (1988), all but one well may be drilled by occupying that spacing unit. The wells would be drilled conventionally as specified in applicable federal regulations and onshore orders.

Surface mitigation measures would be specified for special status species, visual resource management, and cultural resources for wells drilled within the EIS study area.

Under this alternative, Yates Energy Corporation would be able to drill the precise target specified in their APD. Operators within the study area would be managing their operations under existing regulations and onshore orders, which are suitable to allow protection of the environment under normal circumstances. Operators would not incur increased costs for development under this alternative.

However, the Dark Canyon EIS study area has and lies adjacent to significant natural resources which require enhanced protection. Although there is no certainty that a cave or cave passage exists there, there is the possibility of an undiscovered cave or fracture which may communicate with Lechuguilla Cave. With no special mitigation for drilling, completion, and production operations in this sensitive cave/karst environment, cave resources may inadvertently be intercepted and severely impacted by drilling fluids and cement under pressure and casing failures over the life of a well. Without a BLM effort to provide 24-hour-a-day monitoring to ensure enforcement of regulations, a cave resource may be damaged.

ALTERNATIVE B: NO ACTION--DENY APD AND FUTURE DRILLING WITHIN THE EIS STUDY AREA

The result of implementing Alternative B would be to deny the APD and future drilling within the entire EIS study area. This would maintain the status quo with regard to the surface and subsurface resources present within the study area. The existing producing wells on federal leases within the EIS study area would continue to produce.

Approximately 25 bcf (billion cubic feet) of natural gas would not be produced, which would have an approximate value of $32 million. Revenues from federal royalties (of which 50% goes to the New Mexico State Government) of approximately $4 million would not be generated from production of the gas. Revenues would not be apportioned back to Eddy County for use in schools, road repairs, etc.

ALTERNATIVE C: RELOCATE DIAMONDBACK WELL PAD AND USE ENHANCED PRECAUTIONARY OPERATIONS WITHIN THE EIS STUDY AREA (PREFERRED ALTERNATIVE)

Under this alternative, the Yates Energy APD would be approved, however, the well location would be moved east 500 to 563 feet from the east line (FEL) and 2,007 feet from the south line (FSL). This location is based on data developed by the Cave and Karst Task Force in an effort to detect possible cave passages and avoid drilling through them. The specific data used was an identified natural potential anomaly near the original location of the Diamondback well location which could be an indicator of a cave passage or other void.

There would be a reasonable foreseeable development scenario (RFD) of approximately 8 wells within the EIS study area, which would involve the same drilling units and formation targets as presented in Alternative A. The major differences between Alternative C and Alternative A is that the Diamondback location would be moved 500 feet to avoid the potential for a cave, and a site-specific lineament study would be conducted and subsurface mitigative measures would be applied to all wells drilled within the EIS study area. These subsurface mitigative measures would be in addition to the surface mitigation described in Alternative A.

Under this alternative, RFD wells would avoid all known lineaments, natural potential anomalies, and significant helium measurements in order to avoid the likelihood of an undiscovered cave or fracture which may communicate with Lechuguilla Cave. This alternative utilizes the most prudent mitigative measures to effectively diminish the impacts to a cave, small cave passage, or communicating micro-fracture that may be present. Monitoring by a BLM drilling representative would ensure that the mitigative measures are executed by operators within the EIS study area. Alternative C also allows Yates Energy Corporation the opportunity to drill in reasonable proximity to their intended target to test all potentially productive formations without using the more costly and problem-prone directional drilling.

ALTERNATIVE D: DIRECTIONALLY DRILL FROM AN EXISTING WELL PAD, AND USE ENHANCED PRECAUTIONARY OPERATIONS WITHIN THE EIS STUDY AREA

This alternative is designed to help avoid cave resources by drilling from a previously drilled point where it is believed that no cave was intercepted and also to circumvent additional surface disturbance and visual impacts. Under Alternative D, the Diamondback well target would be reached by drilling directionally from the existing pad of the Yates Sidewinder #1 well, for which Yates Energy Corporation is the operator, located on private surface overlying private minerals. The mitigative measures described in Alternative C would also be specified for this alternative.

The operator would need to agree with this alternative if it were selected because it would require that drilling take place off-lease when the lease agreement does not stipulate such. Also, directional drilling would cost the operator more to complete the well and would forego the testing of the Delaware and Bone Springs Formations, two potentially productive horizons over the target. Directional drilling may also have more technical problems associated with it, such as difficulty in obtaining a continuous cement sheath around the casing. This could later allow migration of production fluids from the "directional" portion of the hole up to the cave and water bearing zones of the Capitan Reef.

ALTERNATIVE E: DIRECTIONALLY AND VERTICALLY DRILL TO MULTIPLE TARGETS USING ENHANCED PRECAUTIONARY OPERATIONS FOR THE EIS STUDY AREA

Under this alternative, approximately 4 targets, including the proposed Diamondback Federal #1, would be individually drilled from a new well pad to be located in Section 19, NWSW1/4. (This proposed drilling island is shown on Map 2-1.) There would be a reasonable foreseeable development scenario (RFD) of approximately 8 targets within the EIS study area.

This alternative is designed to mitigate impacts to Lechuguilla and other caves by moving the well pad further from known cave resources, approximately one half mile to the west. It would reduce impacts to the scenic values within the Dark Canyon SMA by eliminating the construction of two well pads. Since the adjacent federal lease to the west, NM-86515, (see Map 2-1) has a no surface occupancy (NSO) stipulation, drilling from this location would also allow that lessee a well pad from which to directionally drill. Because there would be five drill pads instead of seven, impacts from pad and road construction would be somewhat reduced.

Directional drilling under this alternative would have the same potential problems as described in Alternative D.

Chapter 4 of this EIS describes the potential impacts to resources from implementing the applicant's proposed action or the alternatives. Chapter 5 describes the consultation, coordination and public contact made for this project. Information on public comment and the public hearing scheduled for this project is contained in the "Dear Reader" letter at the front of this EIS. Technical material supporting the analysis in the text of this document is found in the appendices.

TABLE S-1
(SOURCE: Dark Canyon EIS Project Files, 1992)
SUMMARY OF ENVIRONMENTAL IMPACTS
BY ALTERNATIVE

	RESOURCES	
ALTERNATIVES	**OIL AND GAS RESOURCES**	**CAVE RESOURCES**
A. **THE PROPOSED ACTION AND CONVENTIONAL DRILLING OF WELLS WITHIN THE EIS STUDY AREA**	1. Gas reserves would be produced, amounting to almost 25 BCF. 2. Additional geologic information about drilling in Cave/Karst formations would be obtained. 3. Up to 8 wells would be drilled within the EIS study area, with an estimated life of 20-30 years.	1. Drilling fluids, cuttings, and cement might enter voids or cave passages, damaging or destroying cave resources and organisms. 2. Failed casing and cement sheaths may allow production fluids and poisonous gases to leak into caves, potentially endangering humans and cave organisms. 3. Penetrations of cave formations could alter the balance of cave atmosphere, impacting speliothem growth. 4. Lined mud pits could leach chemicals into voids or cave formations. 5. Increased traffic would increase potential vandalism and unauthorized use of caves.
B. **NO ACTION ALT.- DENY APD AND FUTURE DRILLING IN THE EIS STUDY AREA**	1. Lessees and operators would be unable to recover current investments in the area. 2. Gas reserves would not be produced (est. at 25 BCF). 3. Existing leases would expire or terminate without further exploration or development. No future leasing would occur.	1. There would be no new impacts to cave resources due to no drilling and production. 2. This alternative would provide the highest level of protection for cave resources due to no additional oil and gas resource development.
C. **RELOCATE WELL PAD AND USE ENHANCED PRECAUTIONARY OPERATIONS WITHIN THE EIS STUDY AREA**	1. Impacts would be similar to Alternative A plus: a. Additional information on drilling in Cave/Karst environment would be obtained from use of on-site BLM drilling expert and use of down-hole video camera when necessary. b. Enhanced precautionary operations would increase costs to operators.	1. Impacts would be similar to Alternative A; however, relocation of the Diamondback well and the site-specific lineament survey would improve the chances of avoiding caves. 2. Impacts would be further reduced by on-site monitoring of drilling, casing, cementing, and production operations.
D. **DIRECTIONALLY DRILL FROM EXISTING WELL PAD AND ENHANCED PRECAUTIONARY OPERATIONS WITHIN THE EIS STUDY AREA**	1. Impacts would be similar to Alternative C, plus: a. Directional drilling would result in additional increased costs to operators.	1. Impacts would be similar to Alternative C.
E. **DIRECTIONALLY AND VERTICALLY DRILL TO MULTIPLE TARGETS AND USE ENHANCED PRECAUTIONARY OPERATIONS WITHIN THE EIS STUDY AREA**	1. Impacts would be similar to Alternatives C and D. 2. An agreement between lessees would be required for use of well pad and equipment.	1. Impacts would be similar to Alternative C, with slightly improved chances for avoiding caves.

TABLE S-1
SUMMARY OF ENVIRONMENTAL IMPACTS BY ALTERNATIVE (CONT.)

	RESOURCES	
ALTERNATIVES	**WATER RESOURCES**	**VISUAL RESOURCES**
A. THE PROPOSED ACTION AND CONVENTIONAL DRILLING OF WELLS WITHIN THE EIS STUDY AREA	1. Increased soil erosion would occur due to surface disturbance pads, pipelines, and roads, causing some degradation of groundwater quality from sediment, dissolved salts, and hydrocarbons. 2. There would be temporary increase in ground water PH adjacent to well bore. 3. Failed casing or cement sheaths may allow production fluids or other contaminants to enter ground water.	1. VRM class II conditions would not be maintained in those portions of the EIS study area, as landscape character would be changed by the reasonable foreseeable development. 2. Drilling locations would disrupt the form, line, color, and texture of the landscape, which would degrade the visual quality of Dark Canyon. 3. Drilling operations and incidental traffic in the EIS study area (servicing the developing gas field) would increase airborne dust and noise pollution.
B. NO ACTION ALT. - DENY APD AND FUTURE DRILLING IN THE EIS STUDY AREA	1. No impacts to water resources would occur from new development. 2. This alternative would provide the highest level of protection for water resources.	1. No impacts to visual resources would occur.
C. RELOCATE WELL PAD AND USE ENHANCED PRECAUTIONARY OPERATIONS WITHIN THE EIS STUDY AREA	1. Impacts would be similar to Alternative A; however, relocating the Diamondback Well would reduce potential for encountering large voids. 2. Avoidance of large voids would reduce impacts of contaminants entering ground water. 3. Use of steel pits would minimize leaching of drilling fluids into a perched aquifer.	1. Impacts to visual resources would be similar to Alternative A, except that the use of additional surface mitigation measures would reduce the degree of visual impact.
D. DIRECTIONALLY DRILL FROM EXISTING WELL PAD AND ENHANCED PRECAUTIONARY OPERATIONS WITHIN THE EIS STUDY AREA	1. Impacts would be similar to Alternative C.	1. Impacts would be similar to Alternative C.
E. DIRECTIONALLY AND VERTICALLY DRILL TO MULTIPLE TARGETS AND USE ENHANCED PRECAUTIONARY OPERATIONS WITHIN THE EIS STUDY AREA	1. Impacts would be similar to Alternative C plus: a. Single well pad serving 4 wells would reduce surface disturbance and associated risks of groundwater contamination.	1. Impacts would be similar to Alternative C.

TABLE S-1
SUMMARY OF ENVIRONMENTAL IMPACTS
BY ALTERNATIVE (CONT.)

ALTERNATIVES	RESOURCES	
	SOCIAL AND ECONOMIC CONDITIONS	WILDERNESS
A. THE PROPOSED ACTION AND CONVENTIONAL DRILLING OF WELLS WITHIN THE EIS STUDY AREA	1. Up to 160 people would be exposed to sights and sounds of an active drilling rig during drilling, servicing, and abandonment of 8 wells impacting back-country experiences. 2. 25 BCF (approx.) of gas would be produced, with royalty value of about $4 million to the Federal, State, and County governments. 3. Gross receipts for taxes collected would support some public services (schools, etc.)	1. BLM's Mudgetts WSA and the NPS wilderness area would be indirectly impacted by the proposed action; wilderness experience back-country for visitors would be degraded by noise, sights, and smells of drilling activities.
B. NO ACTION ALT. - DENY APD AND FUTURE DRILLING IN THE EIS STUDY AREA	1. Salaries from employment in drilling, producing, and maintaining wells would be lost. 2. An estimated 25 BCF of gas would not be produced. 3. Royalties from production would be lost to Federal, State, and County governments. 4. Implementing this alternative would result in government involvement in lengthy and complex litigation.	1. No impacts to wilderness resources would occur.
C. RELOCATE WELL PAD AND USE ENHANCED PRECAUTIONARY OPERATIONS WITHIN THE EIS STUDY AREA	1. Use of enhanced precautionary operations would increase costs to operators by an estimated $76,500 per well; under the RFD scenario, 8 wells would increase costs about $600,000. 2. Royalty valves of about $4 million would not be affected.	1. Impacts would be similar to Alternative A.
D. DIRECTIONALLY DRILL FROM EXISTING WELL PAD AND ENHANCED PRECAUTIONARY OPERATIONS WITHIN THE EIS STUDY AREA	1. Impacts would be the same as Alternative C.	1. Impacts would be similar to Alternative A.
E. DIRECTIONALLY AND VERTICALLY DRILL TO MULTIPLE TARGETS AND USE ENHANCED PRECAUTIONARY OPERATIONS WITHIN THE EIS STUDY AREA	1. Impacts would be the same as Alternative C.	1. Impacts would be similar to Alternative A.

TABLE S-1
SUMMARY OF ENVIRONMENTAL IMPACTS BY ALTERNATIVE (CONT.)

ALTERNATIVES	RESOURCES	
	CULTURAL RESOURCES	**SOILS**
A. THE PROPOSED ACTION AND CONVENTIONAL DRILLING OF WELLS WITHIN THE EIS STUDY AREA	1. The Diamondback Federal No. 1 well has had a class III inventory, indicating no impacts to cultural resources would occur. All other wells potentially drilled under the RFD scenario would also be subject to class III inventory prior to any development. Therefore, no impacts to cultural resources would be expected under the RFD scenario.	1. Fertility of soils near Diamondback or other RFD wells would be reduced and erosion would increase. 2. A maximum of 90 acres would be disturbed by pad, road, and pipeline construction within the EIS study area.
B. NO ACTION ALT. - DENY APD AND FUTURE DRILLING IN THE EIS STUDY AREA	1. No impacts to cultural resources would occur.	1. No impacts to soils would occur.
C. RELOCATE WELL PAD AND USE ENHANCED PRECAUTIONARY OPERATIONS WITHIN THE EIS STUDY AREA	1. Impacts would be similar to Alternative A.	1. Impacts would be similar to Alternative A.
D. DIRECTIONALLY DRILL FROM EXISTING WELL PAD AND ENHANCED PRECAUTIONARY OPERATIONS WITHIN THE EIS STUDY AREA	1. Impacts would be similar to Alternative A.	1. Impacts would be similar to Alternative A.
E. DIRECTIONALLY AND VERTICALLY DRILL TO MULTIPLE TARGETS AND USE ENHANCED PRECAUTIONARY OPERATIONS WITHIN THE EIS STUDY AREA	1. Impacts would be similar to Alternative A.	1. Impacts would be similar to Alternative A, except there would be a slight reduction in degree of impact due to 2 less drill pads and less pipeline and road construction - approx. 56 acres disturbed.

TABLE S-1
SUMMARY OF ENVIRONMENTAL IMPACTS
BY ALTERNATIVE (CONT.)

ALTERNATIVES	RESOURCES	
	VEGETATION	WILDLIFE
A. THE PROPOSED ACTION AND CONVENTIONAL DRILLING OF WELLS WITHIN THE EIS STUDY AREA	1. Vegetation would be eliminated in event of spills or leaks of hydrocarbons, produced water, or chemicals near well sites. 2. Under the proposed action, about 50 acres of vegetation would be lost. However, only about 17 acres would be lost for the lifetime of the project (about 25 years).	1. The proposed action/RFD in the EIS study area would minimally disrupt wildlife habitat on about 50 acres; however, only about 17 acres of habitat would be lost for the lifetime of the project (approx. 25 years).
B. NO ACTION ALT. - DENY APD AND FUTURE DRILLING IN THE EIS STUDY AREA	1. No impacts to vegetation would occur.	1. No impacts to wildlife or habitat would occur.
C. RELOCATE WELL PAD AND USE ENHANCED PRECAUTIONARY OPERATIONS WITHIN THE EIS STUDY AREA	1. Impacts would be similar to Alternative A.	1. Impacts would be similar to Alternative A.
D. DIRECTIONALLY DRILL FROM EXISTING WELL PAD AND ENHANCED PRECAUTIONARY OPERATIONS WITHIN THE EIS STUDY AREA	1. Impacts would be similar to Alternative A, except about 45 acres would be disturbed.	1. Impacts would be similar to Alternative A, except about 45 acres of habitat would be temporarily lost and 17 acres over the lifetime of the project.
E. DIRECTIONALLY AND VERTICALLY DRILL TO MULTIPLE TARGETS AND USE ENHANCED PRECAUTIONARY OPERATIONS WITHIN THE EIS STUDY AREA	1. Impacts would be similar to Alternative A, except about 28 acres would be disturbed. However, only about 14 acres would be lost for the lifetime of the project.	1. Impacts would be similar to Alternative A, except only about 28 acres of habitat would be temporarily lost and only 14 acres over the lifetime of the project.

TABLE S-1
SUMMARY OF ENVIRONMENTAL IMPACTS
BY ALTERNATIVE (CONT.)

	RESOURCES	
ALTERNATIVES	SPECIAL STATUS SPECIES	
A. THE PROPOSED ACTION AND CONVENTIONAL DRILLING OF WELLS WITHIN THE EIS STUDY AREA	1. All special status species of wildlife are migrants and should not be affected by the proposed action. 2. Construction activities of up to 50 acres could destroy any special status plant species and migrant animal species in the immediate vicinity, if present; however, BLM will require the species surveys prior to any on-the-ground activities which would then allow for mitigation of any impacted species and habitat. 3. BLM-required T & E surveys would increase costs for operators by delaying drilling plus adding the cost of the survey itself.	
B. NO ACTION ALT. - DENY APD AND FUTURE DRILLING IN THE EIS STUDY AREA	1. No impacts to special status species would occur.	
C. RELOCATE WELL PAD AND USE ENHANCED PRECAUTIONARY OPERATIONS WITHIN THE EIS STUDY AREA	1. Impacts would be similar to Alternative A.	
D. DIRECTIONALLY DRILL FROM EXISTING WELL PAD AND ENHANCED PRECAUTIONARY OPERATIONS WITHIN THE EIS STUDY AREA	1. Impacts would be similar to Alternative A.	
E. DIRECTIONALLY AND VERTICALLY DRILL TO MULTIPLE TARGETS AND USE ENHANCED PRECAUTIONARY OPERATIONS WITHIN THE EIS STUDY AREA	1. Impacts would be similar to Alternative A, except only 56 acres would be potentially affected.	

CHAPTER 1
PURPOSE AND NEED

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PURPOSE AND NEED

Because of concerns regarding the protection of cave resources in the vicinity of Dark Canyon, particularly Lechuguilla Cave, the Bureau of Land Management (BLM) is preparing an Environmental Impact Statement (EIS) on the impacts from reasonable foreseeable development (RFD) of oil and gas resources. This study includes an analysis of Yates Energy Corporation's Application for Permit to Drill (APD) the Diamondback Federal #1 well on federal lease NM-62161 (see Appendix G). The EIS will inform the decisionmaker (the BLM State Director) and the public of five reasonable alternatives that would avoid or minimize adverse impacts or enhance the quality of the human environment.

THE EIS PROCESS

Under the provisions of the Council of Environmental Quality (CEQ) regulations, when a proposed action is projected to have potentially significant effects on the quality of the human environment, an EIS must be prepared.

Preparation of an EIS follows six basic steps:

1. Scoping the EIS.
2. Conducting the environmental analysis of the proposed action, reasonable forseeable development, and alternatives and preparing the draft EIS.
3. Issuing the draft EIS for public and agency review and comment.
4. Analyzing public comments and preparing the final EIS.
5. Issuing the final EIS, and
6. Reaching and recording the decision (publication of the Record of Decision for the EIS).

Throughout the process of scoping and preparing the EIS, opportunities for the general public, interest groups, industry and other federal and state agencies to comment on the proposal, alternatives and the environmental analysis are continually provided, including public hearings and meetings and soliciting written comments. Chapter 5, Consultation and Coordination, covers the public participation effort to date for this EIS.

DESCRIPTION OF THE EIS AREA

The Dark Canyon Environmental Impact Statement (EIS) study area encompasses approximately 8,320 acres in Eddy County, New Mexico, about 10 miles southwest of the City of Carlsbad. The study area is in the BLM Carlsbad Resource Area and totally encompasses the Dark Canyon Special Management Area (SMA), noted for its rugged and scenic landscape and cave resources. The area is accessed by unimproved dirt roads on the floor of Dark Canyon and by a rugged jeep trail above in the limestone cliffs. (See Location Map 1-1, SMA Map 1-2 and the EIS Study Area Map 1-3.)

The EIS study area lies east of the Lincoln National Forest and immediately north of Carlsbad Caverns National Park (CCNP). On the north end of CCNP is Lechuguilla Cave. Known boundaries of this cave lie within CCNP. Lechuguilla Cave is currently known to be 1,593 feet deep, with about 59 miles of mapped passageways. Lechuguilla Cave is the deepest--and fourth longest--cave in the United States. The most recent discoveries are trending in a northwesterly direction, toward the EIS study area and the applicant's proposed action.

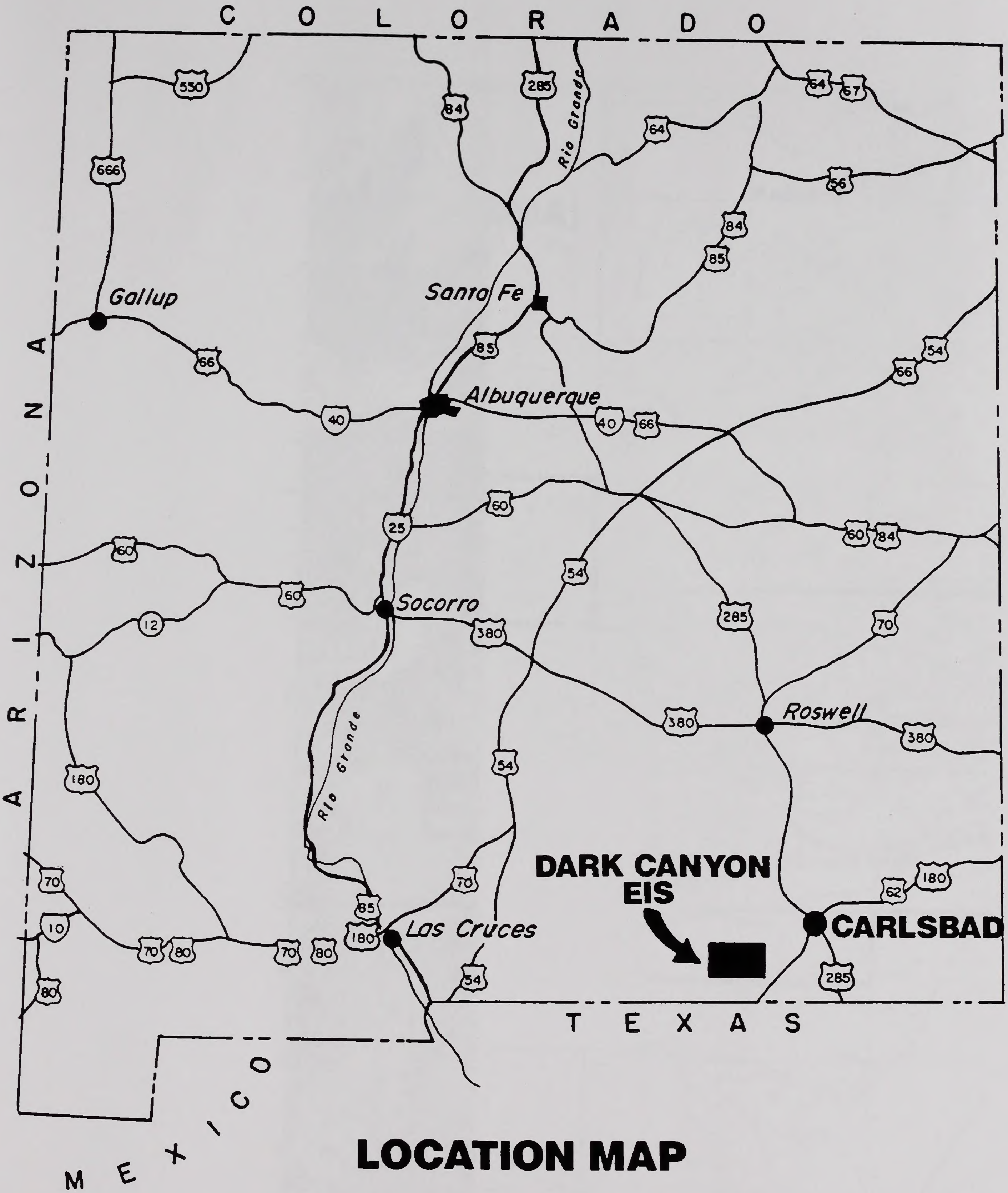
Of the total 8,320 acres within the study area, 8,000 acres are federal mineral interest, 7,200 acres of this being federal surface. Most of the federal mineral acreage is under oil and gas lease, with 1,360 acres currently unleased. Yates and Moncrief have drilled 6 oil and gas test wells within the study area between 1977 and 1990. Of these, 2 wells are currently producing natural gas, 2 are shut-in, and 2 are dry and abandoned. The total production from the 2 producing wells has been about 2.17 billion cubic feet (bcf) of natural gas to date.

AUTHORIZING ACTIONS AND RELATIONSHIP TO STATUTES, REGULATIONS OR OTHER PLANS

Oil and gas leasing and development is authorized under the Mineral Leasing Act of 1920, as amended, and the Federal Land Policy and Management Act of 1976 (FLPMA). The Federal Cave Resources Protection Act of 1988 and the State of New Mexico's Cave Protection Act (passed in 1981) define the required protection for caves and affect the extent of any proposed development that could damage nearby caves.

The BLM is responsible for setting well spacing requirements on federal and Indian lands for the purpose of ensuring the efficient production of hydrocarbons. The New Mexico Oil Conservation Division (NMOCD) establishes spacing for statewide use during public hearing procedures. The BLM reviews the results of these hearings to accept or reject the state's spacing. All drilling proposals must conform with the federal onshore orders and regulations of BLM.

While the location of the proposed Diamondback well is on private surface, the BLM, as the subsurface management agency, is responsible for ensuring that actions taken as a result of the agency's approval of a proposal comply with the regulations implementing the National Environmental Policy Act (NEPA). Under



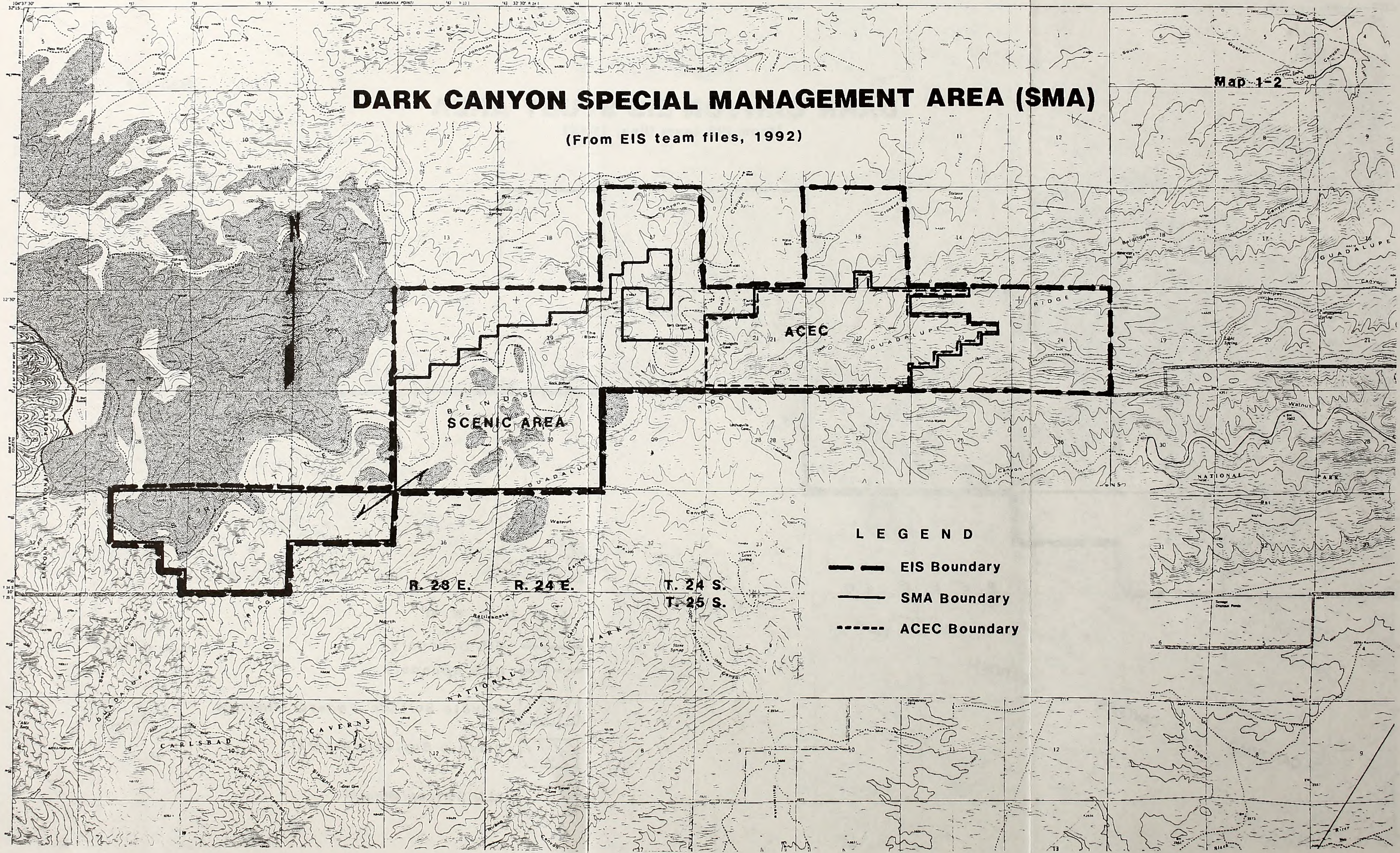
LOCATION MAP

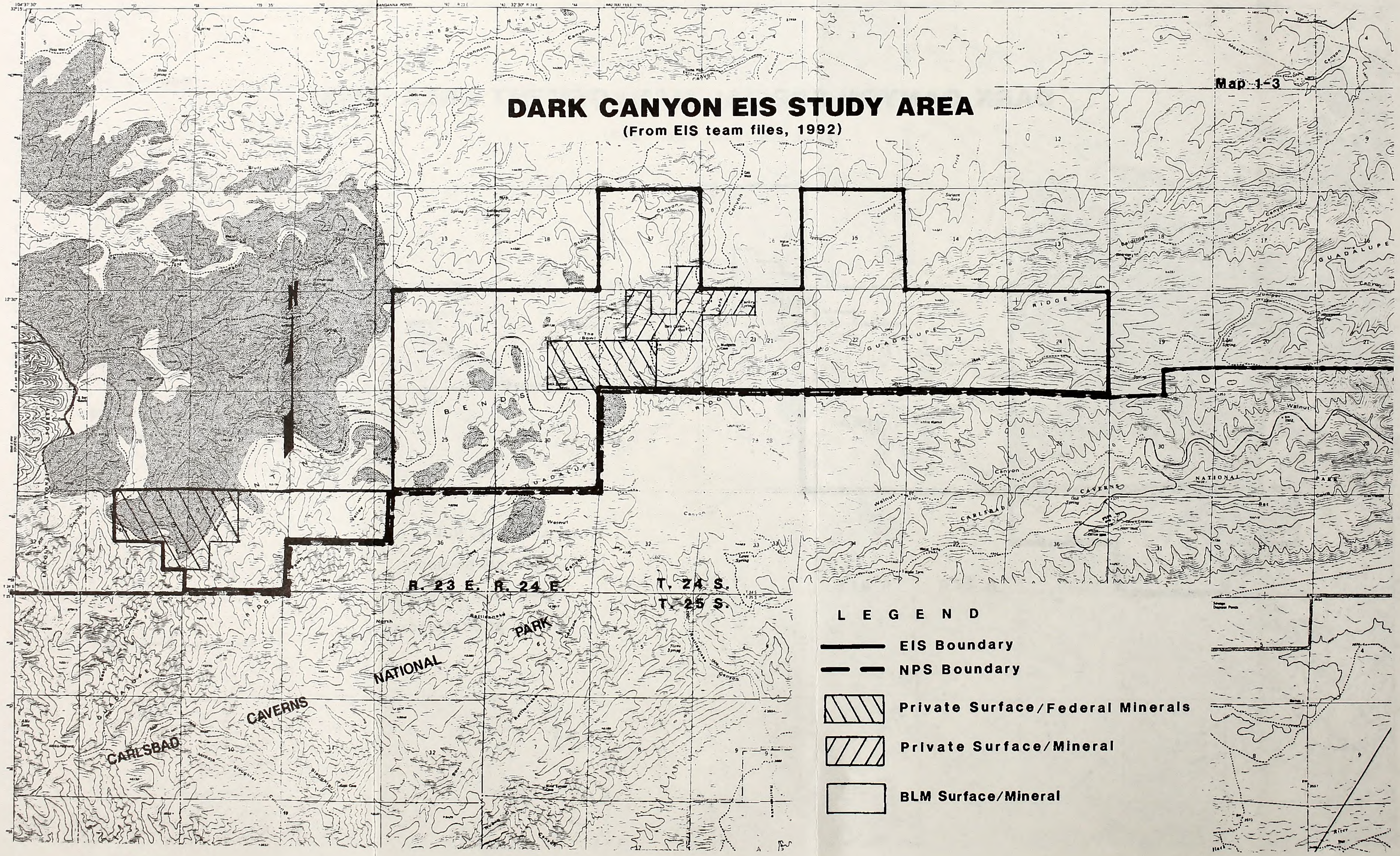
(From BLM files, 1992)

Map 1-2

DARK CANYON SPECIAL MANAGEMENT AREA (SMA)

(From EIS team files, 1992)





Map 1-3

DARK CANYON EIS STUDY AREA

(From EIS team files, 1992)

NEPA and other laws and regulations, BLM is responsible for assessing the impacts of the agency's actions, imposing mitigative measures where needed and considering reasonable alternatives to the proposed action. Therefore, BLM's responsibilities on split estate lands (federal minerals, private surface) are the same as for federal surface.

The EIS study area includes 9 Federal oil and gas leases, issued between 1970 and 1991 with either 5 or 10 year primary terms. (The leases which are not producing at the end of their primary terms will terminate.) These leases confer a right to develop the lease, within the constraints contained in the terms and conditions of the lease, any stipulations attached to the lease, and any reasonable mitigations of impacts developed through an environmental analysis.

The stipulations which apply to each of the leases within the study area are shown in Appendix C. At the time federal lease NM-62161 (which includes the proposed Diamondback well) was issued in 1985, the guidance established in the *"Environmental Assessment for Oil and Gas Leasing in the Roswell District"* (1981) was used to prescribe lease stipulations. However, there is insuffiecent protection of cave resources with the lease stipulations in this lease and in the three other leases issued prior to the approval of the *Carlsbad Resource Management Plan (RMP)*.

When the RMP was approved in 1988, it established the Dark Canyon Special Management Area (SMA) along the northern boundary of CCNP (see Map 1-2). The RMP prescription for the SMA is to emphasize protection of the high visual and natural resource values and rare plant species while providing for other multiple resource uses. The RMP established "no surface occupancy" (NSO) stipulations for portions of new oil and gas leases, avoidance of future right-of-way (ROW) actions in the SMA, restriction of surface disturbance to minimize visual and environmental impacts, closure of this area to mineral material sales, limitations on off road vehicle (ORV) use to designated routes, restrictions on geophysical exploration to conform with ORV limitations, and management of the area to meet Class II and Class III visual resource management guidelines (visual resource management ratings are shown in Appendix E-2).

During 1990, a Management Plan specific to the Dark Canyon SMA was approved, designating an Area of Critical Environmental Concern (ACEC) and a scenic area. Located within the ACEC portion is the Mudgetts Wilderness Study Area (WSA), (shown on Map 3-12: note that foldout maps are bound at the back of this volume).

However, although four of the nine leases within the EIS study area were issued prior to the RMP and prior to the more retrictive lease stipulations prescribed by the RMP, any proposals for surface-disturbing activities within the SMA must still be considered in the context of these management prescriptions.

As of the writing of this document, an amendment for oil and gas is being prepared for the existing Carlsbad RMP, which would involve leasing and operations planning within the Carlsbad Resource Area. The draft is scheduled to be published and comments solicited during September 1993. Concurrently with this EIS, a BLM handbook entitled *"Oil and Gas Drilling and Operations in Cave and Karst Areas"* is being prepared, with publication in final form during early 1993.

CHAPTER 2
ALTERNATIVES INCLUDING THE PROPOSED ACTION

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ALTERNATIVES INCLUDING THE PROPOSED ACTION

INTRODUCTION

This EIS analyzes five alternatives in order that management concerns and the issues raised during scoping may be addressed for drilling and producing oil and gas resources. Alternatives A, C, D, and E have similar reasonable foreseeable development (RFD) scenarios for oil and gas resources (see Appendix A). Alternative B is the "No Action" alternative. The two major resources identified as potentially being impacted are BLM and NPS administered caves, especially Lechuguilla Cave on adjacent NPS lands, and the Capitan aquifer, which supplies drinking water to the City of Carlsbad. All of the development alternatives (A,C,D, and E) have surface mitigative measures incorporated to reduce impacts to visual, cultural and biological resources.

The development alternatives, excluding the proposed action (C, D, and E), incorporate management prescriptions for the proposed Diamondback Federal #1 well and other RFD wells which specifically protect cave resources through avoidance and mitigation. These measures should also protect water resources.

In order to help avoid development near cave resources, existing information derived from three cave detection studies associated with the Cave and Karst Committee was used for cave avoidance. This data includes the identification of lineaments by surface geology mapping and aerial photographs; results of a natural-potential geophysical survey; and results of a helium release experiment. These studies are explained in more detail in the Cave Resources section of Chapter 3, Affected Environment. Locations where there are known lineaments, natural potential anomalies, or elevated helium concentrations would be avoided.

Also, the BLM would conduct site-specific lineament surveys for each APD submitted within the EIS study area to further support avoidance. This would parallel and enhance the broad aerial photograph study performed by Jagnow (1991) for lineament detection. A proposed site would be moved in order to avoid being within 200 feet of a known lineament.

Mitigation, as defined in Appendix B, would be incorporated into Alternatives C, D, and E for drilling, completion, production, and abandonment of wells. These measures go well beyond current federal regulations and onshore orders so that the potential impacts to cave and water resources within the EIS study area would be reduced.

ALTERNATIVE A: THE PROPOSED ACTION AND CONVENTIONAL DRILLING OF WELLS WITHIN THE EIS STUDY AREA

Alternative A incorporates Yates Energy Corporation's drilling proposal in addition to other development within the EIS study area. (The proposed well location and other leases in the area are shown on Map 2-1.) Under Alternative A, the Application for Permit to Drill (APD) the Diamondback Federal #1 well would be approved virtually as submitted (see Appendix G, Well Applications and Agreements). The reasonable foreseeable development scenario (RFD) is based upon 320-acre gas drilling units, and would include approximately 8 wells within the EIS study area (these wells are shown on Map A-1 in Appendix A). Because only one of the leases with projected RFD was issued subsequent to the RMP (1988), all but one well may be drilled by occupying that spacing unit (see the lease stipulations in Appendix C).

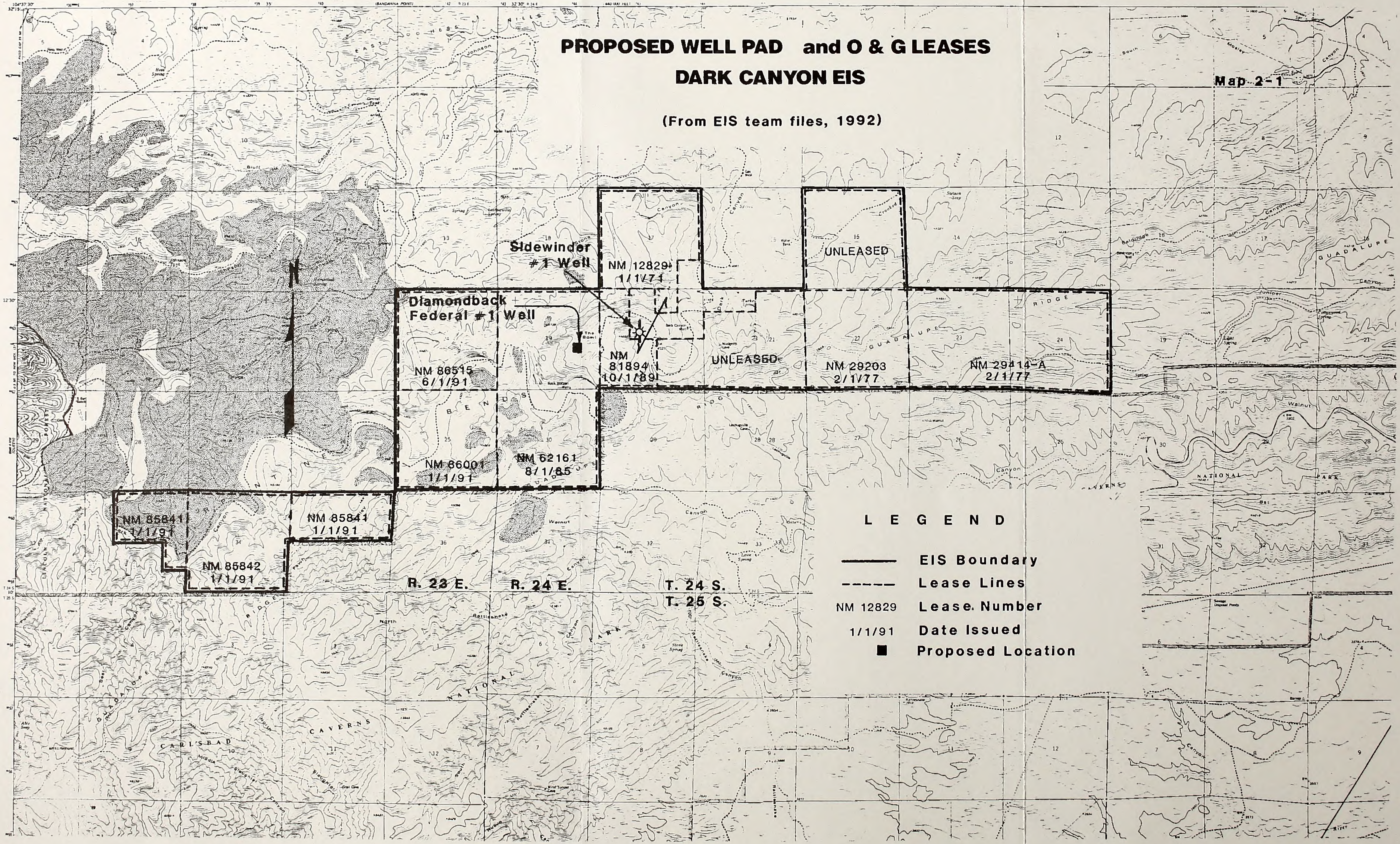
Under this scenario, full-field development of the EIS study area would include the following spacing units, (well numbers from Appendix A, Reasonable Foreseeable Development).

Well #1	E1/2, Sec. 19, T. 24 S., R. 24 E.,
Well #2	W1/2, Sec. 19, T. 24 S., R. 24 E.,
Well #3	E1/2, Sec. 30, T. 24 S., R. 24 E.,
Well #4	W1/2, Sec. 30, T. 24 S., R. 24 E.,
Well #5	S1/2, Sec. 23, T. 24 S., R. 24 E.,
Well #6	W1/2, Sec. 24, T. 24 S., R. 24 E.,
Well #7	E1/2, Sec. 24, T. 24 S., R. 24 E.,
Well #8	E1/2, Sec. 24, T. 24 S., R. 23 E.

Each spacing unit would be reached by a well located on that spacing unit, with the exception of E1/2, Sec. 24, T. 24 S., R. 23 E., which would be drilled directionally because of a "no surface occupancy" stipulation (NSO) for lease NM-86515.

The general drilling operations for the applicant's proposed Diamondback well are shown below and could similarly be applied to other wells within the RFD for this alternative.

The wells would be drilled conventionally as specified in applicable federal regulations and onshore orders. Each well would be drilled to a total depth of approximately 10,500 feet. The purpose of each of the wells would be to test the Morrow and four other formations, with the intent of producing natural gas and possibly oil. Three casing strings would normally be used: 13 3/8" from the surface to about 350 feet; 8 5/8" from the surface to about 2,600 feet; and 4 1/2" or 5 1/2" from the surface to the total depth. Following approval of an APD, it would take approximately 6 days to construct the road and pad, another day to set up the drilling rig, and approximately 35 days to drill each



PROPOSED WELL PAD and O & G LEASES
DARK CANYON EIS

(From EIS team files, 1992)

Map 2-1

of the wells.
In general terms, access would be via existing roads to each of the 8 well locations, with roads upgraded or constructed as needed. (If the current access to locations for RFD wells 1, 2, 3, 4, and 8 were to be used, then 1/2 mile of the roadbed would be within CCNP, and the appropriate special use permit would be required from the NPS Southwest Region.)

The drilling pad would then be constructed. Upon completion of the pad, the drilling rig and associated equipment would be trucked to the site and set up, the well would be drilled, and the drilling rig and other equipment would then be removed. If the well were a producer, production equipment would be installed on the site and a pipeline would be constructed. Production facilities would include a wellhead, Christmas tree, meter house, compressor and possibly a dehydrator for a gas well. If oil were produced, the equipment would also include storage tanks, gunbarrel gravity separator, heater treater, and a pump jack. If the well were dry, equipment would be removed from the site and the pad would be reclaimed.

The well pads would occupy about 2 acres each. A total of about 1.3 miles of new or improved roads would have to be built, assuming that the existing roads shown on USGS topographic maps as "unimproved" need no major work. The width of these roads would be approximately 14 feet, with a 12 foot driving surface, resulting in a further 3 acres of surface disturbance. Under this scenario, surface disturbance for drill pads and roads would be about 17 acres.

Natural gas pipelines would follow existing access routes and probably tie to an El Paso pipeline gathering system in T. 24 S., R. 24 E., section 16, NE1/4 NW1/4. The exception to this would be that the proposed pipeline would not follow the Dark Canyon road through the 1/2 mile of NPS lands, and would require a bypass to remain within the EIS study area. (Table 2-1 indicates the surface disturbance for construction of gas pipelines to each RFD well.) The total surface disturbance for pipelines would be about 73 acres. The total surface disturbance under this scenario would be about 90 acres.

TABLE 2-1

NATURAL GAS PIPELINE SURFACE DISTURBANCE FOR EACH WELL

(Well numbers tiered to Reasonable Foreseeable Development Map A-1, in Appendix A.)

Well No.	**Disturbance (acres)**
Add for pipeline access to wells 1, 1A, 2, 3, 4 and Sidewinder	24.68
1	.15
1A	.57
2	11.25
3	4.48
4	5.62
Sidewinder	1.15
Add for pipeline access to wells 5, 6 and 7	14.92
5	.11
6	4.02
7	6.77
8	0

(**Source:** BLM Dark Canyon EIS Project Files, 1992.)

The pipeline would be a two-inch seamless steel line with 3200 pound working pressure laid on the surface along the existing road alignment and buried at the crossings of the Dark Canyon drainage. (Map A-1 indicates the course of pipelines to the foreseeable wells.)

Sections of pipe would be trucked to the alignment of the pipeline and assembled on site. For the buried sections, a trench would be constructed with a trencher or backhoe. Construction material such as caliche (for surfacing of the road and the well pad) would be taken from the pad area or from an trench would be constructed with a trencher or backhoe. Construction material such as caliche (for surfacing of the road and the well pad) would be taken from the pad area or from an approved pit location.

Surface mitigation measures would be specified for special status species (Appendix D), visual resource management (Appendix E), and cultural resources (Cultural Resources section of Chapter 4, Environmental Consequences) for wells drilled within the EIS study area. For special status species and cultural resources, BLM would require that the operator provide an inventory so that an assessment and the necessary mitigation may be done. Mitigation for visual resource management (VRM) includes conditions of approval which affect well pads, roads, pipelines, and production facilities. However, the VRM Class II management prescription would not be met under any of the development alternatives.

Under this alternative, Yates Energy Corporation would be able to drill the precise target specified in their APD. Operators within the EIS study area would be managing their operations under existing regulations and onshore orders, which are suitable to allow protection of the environment under normal circumstances. Operators would not incur increased costs for development under this alternative. Approximately 25 bcf of natural gas would be produced, which would have a value of about $32 million. Federal royalties (of which 50% goes to the state) would be about $4 million.

However, the Dark Canyon EIS study area has, and is adjacent to, significant natural resources which require enhanced protection. Under this alternative, the Diamondback Federal #1 well would lie within 100 feet of a known natural potential anomaly measuring approximately 300 x 800 feet in area. Although there is no certainty that a cave or cave passage exists here, there is the possibility of an undiscovered cave which may communicate with Lechuguilla Cave. With no special mitigation for drilling, completion, and production operations in this sensitive cave/karst environment, cave resources may inadvertently be intercepted and severely impacted by drilling fluids and cement under pressure and casing failures over the life of a well. Without a BLM effort to provide 24-hour-a-day monitoring to ensure enforcement of regulations, and implementation of more protective conditions of approval, a cave resource may be damaged.

ALTERNATIVE B: NO ACTION--DENY APD AND FUTURE DRILLING WITHIN THE EIS STUDY AREA

No action is not possible in this situation, since an APD must be either approved or denied. The result of implementing Alternative B would be to deny the APD and future drilling within the entire EIS study area. This would maintain the status quo with regard to the surface and subsurface resources present within the study area. However, the existing producing wells on federal leases (between 2 and 4 wells) within the EIS study area would continue to produce.

Approximately 25 bcf of natural gas would not be produced, which would have an approximate value of $32 million. Revenues from federal royalties (of which 50% goes to New Mexico) of approximately $4 million would not be generated from production of the gas. These revenues would not be apportioned back to Eddy County for use in schools, road repairs, etc.

Scenarios for Present Leases Under the No Action Alternative

If the Record of Decision (ROD) for the EIS were to be the No Action Alternative, the Diamondback Federal #1 well would not be drilled and future development of existing oil and gas leases within the EIS study area would also be denied.

The following is a brief analysis of some of the possible scenarios which could apply to the disposition of federal leases within the EIS study area:

1. **Relinquishment, Termination, & Expiration:** Leases within the study area that are not held by production could be voluntarily relinquished by the lessee, with back payments of rentals reimbursed by the BLM to each of the lessees. Other scenarios include lease termination as a result of failure of the lessees to pay rentals or the leases would expire at the end of their primary terms, with the last lease expiring during 1997, for lack of production.

2. **Purchase or Exchange of Lease Rights:** Current laws and regulations do not provide for the purchase or exchange of oil and gas lease rights. In fact, an exchange of oil and gas leases would violate the Federal Onshore Oil and Gas Leasing Reform Act of 1987 which directs that all oil and gas leases must be competitively sold. Even if legislation were passed to effect exchanges of leases, it would be a very complex and time-consuming process. All parties would have to agree on the method of appraising the fair market value of the oil and gas rights. Oil and gas leases of comparable value would need to be identified, and these would need to be available outside of the EIS study area. BLM management has determined that this option

to purchase or exchange leases is not in the best interest of the public, as it would likely result in lengthy litigation over fair market value.

Purchase would involve only those 6 leases not held by production. The other 3 leases held by production would continue to produce gas. If the purchase or exchange of lease rights included those leases which have producing wells within the EIS study area, the fair market value would include the additional costs to purchase these producing wells; these wells would be permanently plugged and abandoned.

3. Condemnation: The Secretary of the Interior, under Section 205(a) of FLPMA, has the option to exercise the power of eminent domain, or condemnation of federal lands. However, the only case for condemnation is to secure access to public lands. Access clearly would not be the intent of the federal government in this situation.

Scenarios for Precluding Future Leasing and Development Under the No Action Alternative

If the Record of Decision (ROD) were to select the No Action Alternative, BLM could deny future leasing and development within the EIS study area; however, lengthy litigation to determine rights lost by leaseholders could be expected. The EIS study area may be withdrawn from future leasing and development under Section 204(c) of FLPMA by the Secretary of Interior, or by Executive authority of the General Withdrawal Act of 1910 (Pickett Act). The EIS study area may also be withdrawn from future leasing and development by legislation.

ALTERNATIVE C: RELOCATE DIAMONDBACK WELL PAD AND USE ENHANCED PRECAUTIONARY OPERATIONS WITHIN THE EIS STUDY AREA (THE PREFERRED ALTERNATIVE)

Under this alternative, the Yates Energy APD would be approved; however, the well location would be moved east 500 feet to 563 feet from the east line (FEL) and 2,007 feet from the south line (FSL). This location is based on data developed by the Cave and Karst Task Force in an effort to detect possible cave passages and avoid drilling through them (see Cave Detection Methods in the Cave Resources section of Chapter 3, Affected Environment). The specific data used was an identified natural potential anomaly near the original location of the proposed Diamondback well which could be an indicator of a cave passage or other void. (See Maps A-1 and 3-8, which show the proposed Diamondback location--well No.1--and the natural potential anomalies.) Moving the location eastward 500 feet allows a safety factor of 400 feet from any known natural potential anomaly, lineament, or significant helium measurement.

There would be a reasonable foreseeable development scenario (RFD) of approximately 8 wells within the EIS study area (see Appendix A), which would involve the same drilling units and formation targets as presented in Alternative A. Surface disturbance due to well pads, roads, and pipelines, would be about 89 acres. (Table 2-1 indicates the surface disturbance for construction of gas pipelines to each RFD well. Map A-1 indicates the course of pipelines to the foreseeable wells.) The construction of well pads, roads, pipelines, the types of production equipment and facilities to be used, and the rehabilitation of each site would be similar to that described for Alternative A.

The major differences between Alternative C and Alternative A is that the applicant's proposed Diamondback location would be moved 500 feet, cave avoidance would be enhanced through site-specific lineament surveys of all well locations, and subsurface mitigative measures would be applied.

In order to help avoid development near cave resources, existing information derived from three cave detection studies associated with the Cave and Karst Committee has been used for cave avoidance. This data includes the identification of lineaments by surface geology mapping and aerial photographs; results of a natural-potential geophysical survey; and results of a helium release experiment. These studies are explained in more detail in the Cave Resources section of Chapter 3, Affected Environment. Locations where there are known lineaments, natural potential anomalies, or elevated helium concentrations would be avoided.

Also, the BLM would conduct site-specific lineament surveys for each APD submitted within the EIS study area to further support avoidance. This would parallel and enhance the broad aerial photograph study performed by Jagnow (1991) for lineament detection. A proposed site would be moved in order to avoid being within 200 feet of a known lineament.

Appendix B specifies the subsurface mitigative measures, called **"Enhanced Precautionary Operations,"** which would be incorporated into the Diamondback APD and into other drilling applications within the EIS study area. These subsurface mitigative measures would be in addition to the surface mitigation described in Alternative A. This subsurface mitigation would be incorporated into Alternatives C, D, and E for drilling, completion, production, and abandonment of wells. These measures go well beyond current federal regulations and onshore orders so that the potential impacts to resources within the study area would be reduced.

However, drilling applications would still be approved on a case-by-case basis, and BLM would reserve the right to modify the conditions of approval based upon site-specific circumstances and information learned from the drilling of other wells in the area.

Under this alternative, approximately 25 bcf would be produced. RFD wells would avoid all known lineaments, natural potential anomalies, and significant helium measurements in order to avoid the likelihood of an undiscovered cave or fracture which may communicate with Lechuguilla Cave. This alternative utilizes mitigative measures which would reduce the impacts to a cave, small cave passage, or communicating micro-fracture that may be present.

Monitoring by a BLM operations representative would ensure that the mitigative measures are executed by operators within the EIS study area. Alternative C also allows Yates Energy Corporation the opportunity to drill in reasonable proximity to their intended target to test all potentially productive formations without using the more costly and problem-prone directional drilling.

ALTERNATIVE D: DIRECTIONALLY DRILL FROM AN EXISTING WELL PAD, AND USE ENHANCED PRECAUTIONARY OPERATIONS WITHIN THE EIS STUDY AREA

This alternative is designed to help avoid cave resources by drilling from a previously drilled point where it is believed that no cave was intercepted and also to circumvent additional surface disturbance and visual impacts. Under Alternative D, the Diamondback well target would be reached by drilling directionally from the existing pad of the Yates Sidewinder #1 well, for which Yates Energy Corporation is the operator. This pad is located on private surface overlying private minerals in Section 20, SENE1/4, at 2,310 feet from the north line (FNL) and 1,980 feet from the west line (FWL), shown on Map 2-1.

However, according to 43 CFR 3101.1-2, the BLM cannot require an operator to conduct their operations off the leasehold, unless previously stipulated in the lease agreement. Since this stipulation is not in the lease agreement, Yates would need to agree with this alternative.

From the Sidewinder #1 well pad, the Diamondback target would require a surface offset of about 3,100 feet. The ground elevation of the well would be 4,277 feet above sea level. Drilling would be done with a rotary drilling rig, taking an estimated 45-50 days. The "kick-off point" (point where drilling starts to deviate) would be at about 5,465 feet deep and eventually build up to an angle of 34° at about 6,300 feet deep. The true vertical depth of the well would be 10,500 feet and the measured depth would be about 11,420 feet.

Under this alternative, approximately 25 bcf of natural gas would be produced. There would be a reasonable foreseeable development scenario (RFD) of approximately 8 wells within the EIS study area. Full-field development of the EIS study area would be the same as for Alternative A, with the exception of the number of drill sites. Because the spacing unit in the E1/2 of section 19 would be drilled directionally from an existing pad in section 20, there would be one less drill pad and about 0.1 mile less new road construction.

Surface disturbance would be 17 acres for well pads and roads, and about 73 acres for pipeline construction, amounting to 90 acres total surface disturbance. (Table 2-1 indicates the surface disturbance for construction of gas pipelines to each RFD well. Map A-1 indicates the course of pipelines to the foreseeable wells.) The construction of well pads, roads, pipelines, the types of production equipment and facilities to be used, and the rehabilitation of each site would be similar to that described for Alternative A.

BLM would specify in the Diamondback APD and in any other drilling applications within the EIS study area, a lineament study to be performed by the BLM and enhanced precautionary operations as mitigation by the operator. These would be in addition to the surface mitigation discussed under Alternative A. Appendix B specifies the downhole mitigative measures, which would become conditions of approval for drilling, completion, and production. The additional requirements would affect the type of drilling, geophysical logging, testing, casing program, cementing techniques, and on-site monitoring.

Drilling applications would still be approved on a case-by-case basis, and BLM would reserve the right to modify the conditions of approval based upon site-specific circumstances and information learned from the drilling of other wells in the area.

As discussed above, the operator would need to agree with this alternative (if selected) because it would require that drilling take place off-lease when the lease agreement does not stipulate such. This makes this alternative very speculative. Also, directional drilling would cost the operator more to complete the well and would forego the testing of the Delaware and Bone Springs Formations, two potentially productive horizons over the target. Directional drilling may also have more technical problems associated with it, such as difficulty in obtaining a continuous cement sheath around the casing. This could later allow migration of production fluids from the "directional" portion of the hole up to the cave and water bearing zones of the Capitan Reef Complex.

ALTERNATIVE E: DIRECTIONALLY AND VERTICALLY DRILL TO MULTIPLE TARGETS USING ENHANCED PRECAUTIONARY OPERATIONS FOR THE EIS STUDY AREA

Under this alternative, approximately 4 targets, including the proposed Diamondback Federal #1, would be individually drilled from a new well pad to be located in Section 19, NWSW1/4. There would be a reasonable foreseeable development scenario (RFD) of approximately 8 targets within the EIS study area (see Appendix A). Approximately 25 bcf of natural gas would be produced.

This alternative is designed to mitigate impacts to Lechuguilla and other caves by moving the well pad further from known cave resources, approximately one half mile to the west. It would reduce impacts to the scenic values within the Dark Canyon SMA by eliminating the construction of 2 well pads. Since the adjacent federal lease to the west, NM-86515, (see Map 2-1) has a no surface occupancy (NSO) stipulation, drilling from this location would also allow that lessee a well pad from which to directionally drill.

Full-field development of the EIS study area would generally be the same as for Alternative A, with the exception of the number of surface locations. Four spacing units discussed in the RFD (Appendix A) would be tested by individual vertically drilled holes. Three targets would be directionally drilled from the drilling island to spacing units to the west, south, and east, while the spacing unit below the pad in section 19 would be vertically tested. The directional holes would test the following spacing units:

Well #1	E1/2, Sec. 19, T. 24 S., R. 24 E.
Well #4	W1/2, Sec, 30, T. 24 S., R. 24 E.
Well #8	E1/2, Sec. 24, T. 24 S., R. 23 E.

Well #1 (directionally drilled to the Diamondback target) would have a "kick-off point" of about 5,440 feet deep and eventually build to an angle of 30° at about 6,190 feet deep. The true vertical depth would be 10,500 feet and the measured depth would be about 11,205 feet.

Because there would be five drill pads instead of seven, impacts from pad and road construction would be reduced from other development alternatives. However, a pad which can accommodate 4 wells would need to be 4 acres, twice the size of the other pads. Surface disturbance for roads and pads would be about 14 acres. Because there would be two less drilling sites for the complement of 8 targets, a reduction to about 42 acres of surface disturbance for gas pipeline would be required to transport gas from the wells. (Table 2-1 indicates the surface disturbance for construction of gas pipelines to each RFD well. Map A-1 indicates the course of pipelines to the foreseeable wells). Total surface disturbance for this alternative would be about 56 acres.

The construction of well pads, roads, pipelines, the types of production equipment and facilities to be used, and the rehabilitation of each site would be similar to that described for Alternative A. Production equipment and facilities would be reduced because three of the four wells would involve lease NM-62161. However, because one of the directionally drilled wells from the drilling island would be to lease NM-86515, a private contract negotiating the use of the pad would be necessary so that ownership conflicts would be kept to a minimum.

BLM would specify in the Diamondback APD and in any other drilling applications within the EIS study area, a lineament study to be performed by the BLM and enhanced precautionary operations as mitigation by the operator. These would be in addition to the surface mitigative measures discussed in Alternative A. Appendix B specifies the downhole mitigative measures which would be incorporated into the Diamondback APD and into other drilling applications within the EIS study area. There would be conditions of approval for drilling, completion, and production. The additional requirements would affect the type of drilling, geophysical logging, testing, casing program, cementing techniques, and on-site monitoring.

Drilling applications would still be approved on a case-by-case basis, and BLM would reserve the right to modify the conditions of approval based upon site specific circumstances and information learned from the drilling of other wells in the area.

Directional drilling under this alternative would increase costs to the operator to complete the well. It may also have more technical problems associated with it, such as difficulty in obtaining a continuous cement sheath around the casing. This could later allow migration of production fluids from the "directional" portion of the hole up to the cave and water bearing zones of the Capitan Reef Complex. This alternative would preclude the testing of potentially productive horizons over the targets, such as the Delaware and Bone Springs Formations, in the Diamondback well and the RFD #4 well (see Appendix A) in the NW1/4 of section 30.

ALTERNATIVES CONSIDERED BUT DROPPED AS NOT REASONABLE

Alternative B Scenarios: Several possible scenarios for the "No Action" alternative were included under "Alternative B" in the Alternatives section. These were considered but not analyzed in detail because they are not considered reasonable, considering the lengthy litigation that would most likely occur.

Drilling Island: A drilling island with multiple wells drilled through the same borehole (similar to Alternative E, but wells would be drilled through the same borehole) was considered as a mitigative measure in order that the Capitan Reef cave-bearing interval would be penetrated only once instead of 4 times. However, the borehole that would be required to accommodate 4 separate production strings would need to be very large, about 36 inches wide, and in the event of lost circulation or intercept of an unknown cave, could cause catastrophic problems. There would be an undesirable liability because of multiple operators accessing the well with the chance that one operator may damage the production string and casing of the other operator during completion or workovers on the well.

CHAPTER 3
AFFECTED ENVIRONMENT

CHAPTER 3
AFFECTED ENVIRONMENT

INTRODUCTION

This chapter provides information for the portion of the environment that would be affected by the applicant's proposed action or alternatives. The affected environment was analyzed for the following resources:

- Oil and Gas Resources
- Cave Resources
- Water Resources
- Visual Resources (scenic values)
- Social and Economic Conditions
- Wilderness
- Cultural Resources
- Soils
- Vegetation
- Wildlife
- Special Status Species

The detail presented for each resource topic is commensurate with the anticipated level of impact. Technical information directly related to the affected environment or supporting the analysis in this document is included in the appendices. Less critical technical material and the relevant laws and regulations are on file in the Carlsbad Resource Area Office and is available for public inspection. The following descriptions of the affected environment generally focus on the EIS study area but also include the surrounding geographic area.

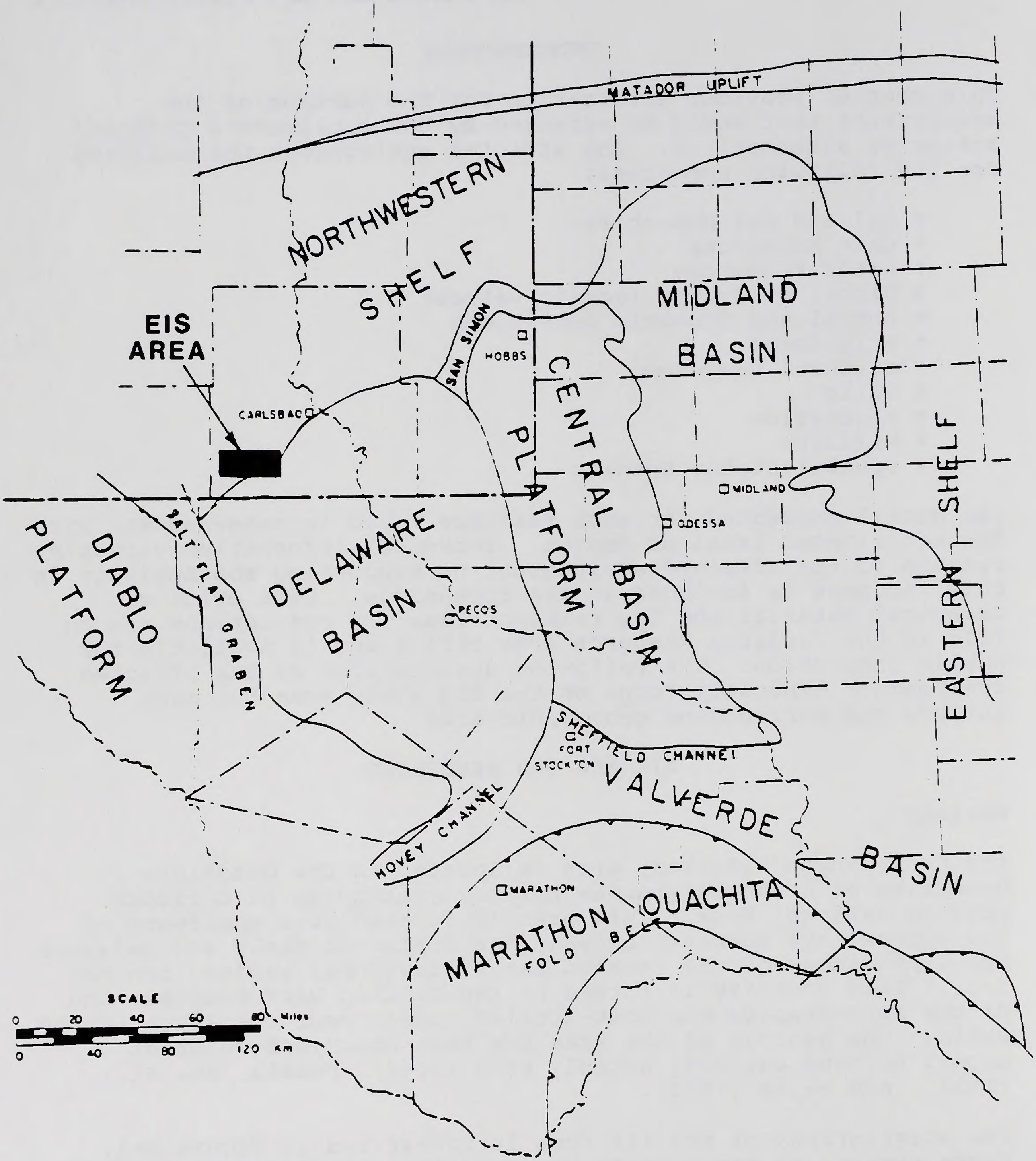
OIL AND GAS RESOURCES

Geology

The Dark Canyon EIS study area is located in the Guadalupe Mountains of southeastern New Mexico, just north of Carlsbad Caverns National Park. This area is located just shelfward of the approximate boundary between the Northwest Shelf and Delaware Basin provinces of the Permian Basin structural region (see Map 3-1). This boundary is formed by the Capitan Reef Complex, one of the best-exposed and most-studied fossil reef complexes in the world. The geology of the area has been described in great detail by many authors, notably King (1948), Newell, et. al., (1953), and Hayes (1964).

The stratigraphy of the EIS area is summarized in Figure 3-1. Rocks exposed at the surface are comprised of the upper portion of the Artesia Group of Permian age: the Tansill, Yates, Seven

Map 3-1



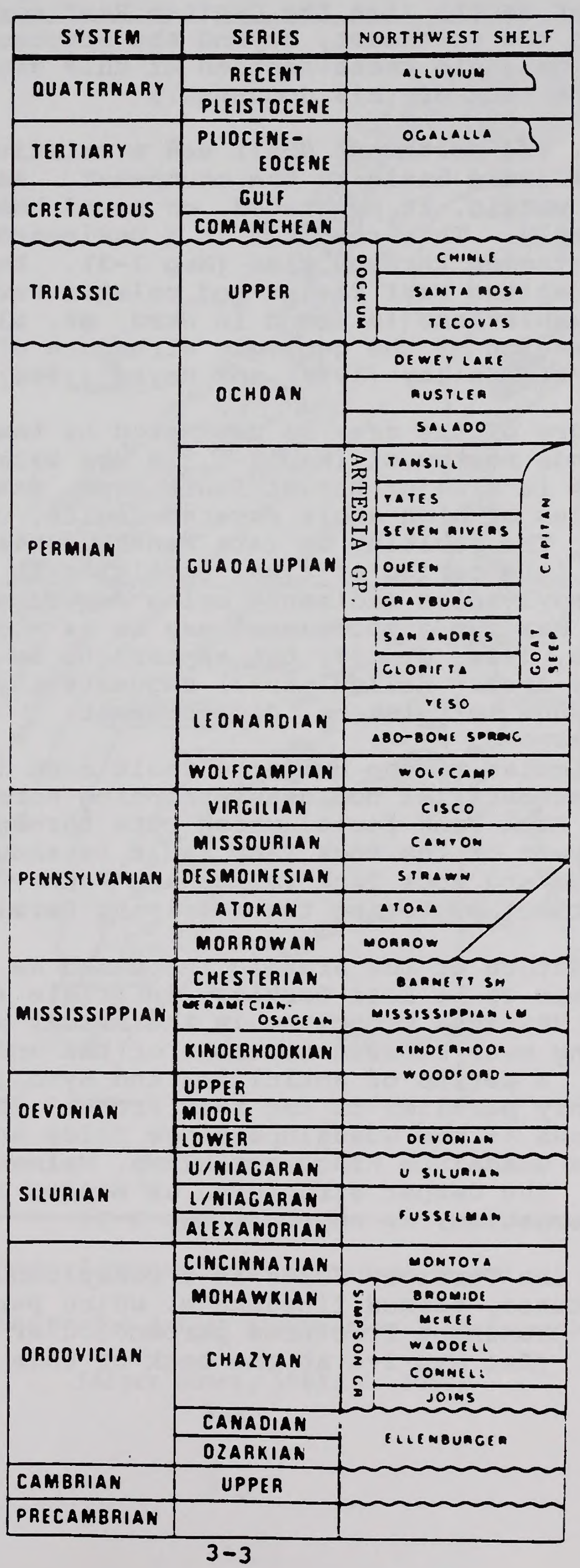
Index map showing provinces of Permian basin region (after Hills, 1984, p.251)

Figure 3-1

GENERALIZED STRATIGRAPHIC COLUMN

NORTHWEST SHELF, SOUTHEASTERN NEW MEXICO

(AFTER JAMES, 1985, p. 1044)



SYSTEM	SERIES		NORTHWEST SHELF	
QUATERNARY	RECENT		ALLUVIUM	
	PLEISTOCENE			
TERTIARY	PLIOCENE-EOCENE		OGALALLA	
CRETACEOUS	GULF			
	COMANCHEAN			
TRIASSIC	UPPER	DOCKUM	CHINLE	
			SANTA ROSA	
			TECOVAS	
PERMIAN	OCHOAN		DEWEY LAKE	
			RUSTLER	
			SALADO	
	GUADALUPIAN	ARTESIA GP.	TANSILL	CAPITAN
			YATES	
			SEVEN RIVERS	
			QUEEN	
			GRAYBURG	
			SAN ANDRES	GOAT SEEP
			GLORIETA	
	LEONARDIAN		YESO	
			ABO-BONE SPRING	
	WOLFCAMPIAN		WOLFCAMP	
PENNSYLVANIAN	VIRGILIAN		CISCO	
	MISSOURIAN		CANYON	
	DESMOINESIAN		STRAWN	
	ATOKAN		ATOKA	
	MORROWAN		MORROW	
MISSISSIPPIAN	CHESTERIAN		BARNETT SH	
	MERAMECIAN-OSAGEAN		MISSISSIPPIAN LM	
	KINDERHOOKIAN		KINDERHOOK	
DEVONIAN	UPPER		WOODFORD	
	MIDDLE			
	LOWER		DEVONIAN	
SILURIAN	U/NIAGARAN		U SILURIAN	
	L/NIAGARAN		FUSSELMAN	
	ALEXANDRIAN			
ORDOVICIAN	CINCINNATIAN		MONTOYA	
	MOHAWKIAN	SIMPSON GR	BROMIDE	
	CHAZYAN		MCKEE	
			WADDELL	
			CONNELL	
			JOINS	
	CANADIAN		ELLENBURGER	
	OZARKIAN			
CAMBRIAN	UPPER			
PRECAMBRIAN				

Rivers, and Queen Formations. These formations represent the backreef or shelf facies of the Permian reef complex. To the southeast (and at depth) lies the Capitan Reef core, with basinal rocks further to the southeast, beyond the spectacular reef escarpment. (A geologic cross-section of this area is shown in Figure 3-2 at the back of this document.)

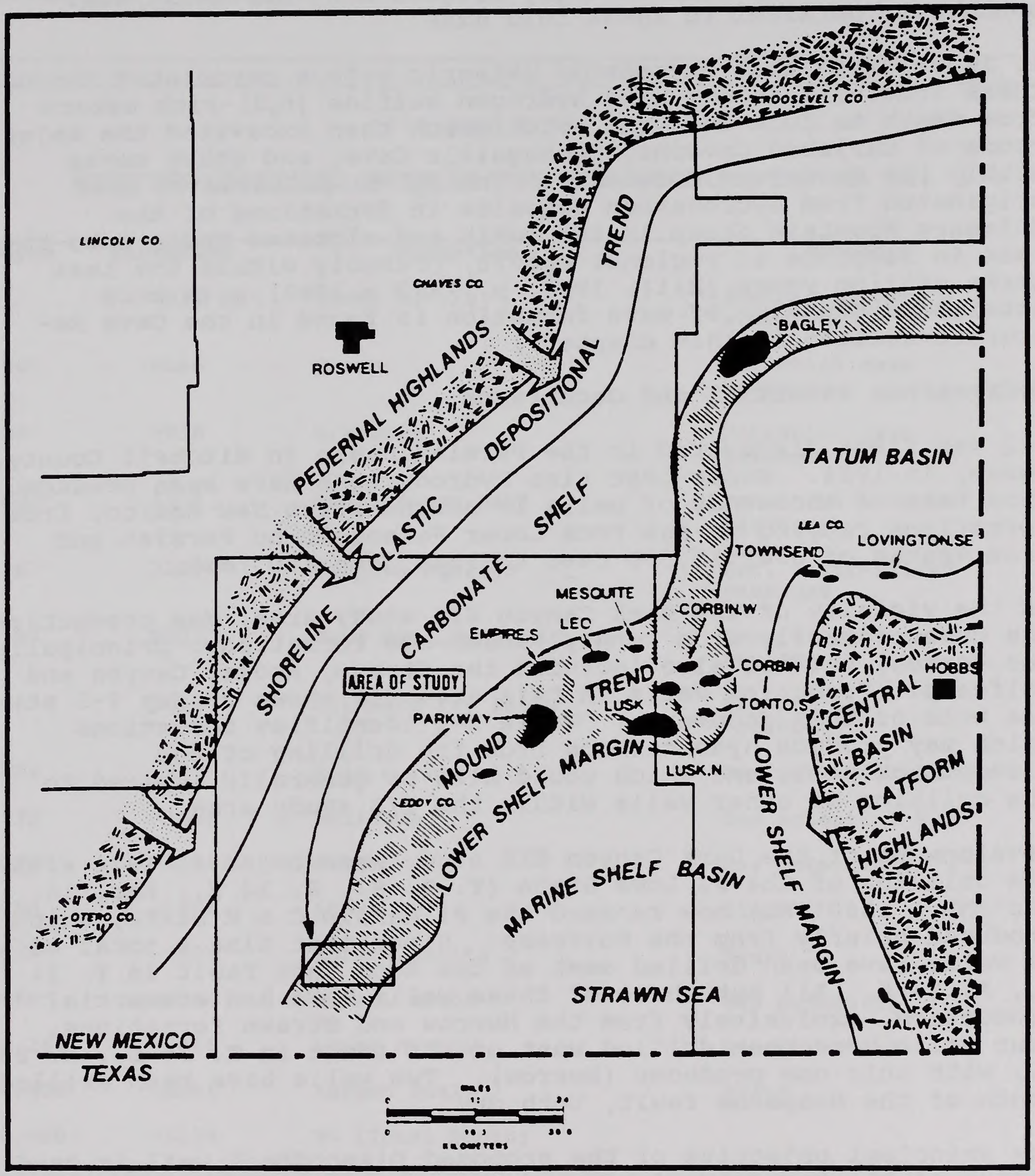
In Permian time, the Northwest Shelf was a relatively shallow sea, with the Delaware Basin to the southeast. As the reef grew along the shelf margin, it prograded, or moved basinward, toward the nutrient supply. This resulted in a basinward migration of the entire reef facies through time (Map 3-2). An excellent description of Capitan reef facies and related Permian hydrocarbon accumulations is found in Ward, et. al. (1986). (For a detailed discussion of the geologic structure of the Guadalupe Mountains area, see Kelley (1972) and Hayes (1964)).

The deep structure of the area is dominated by the Huapache fault zone, which trends northwest (Map 3-3, in the back of this document). This is a major thrust fault zone, described by Hayes (1964) as a series of high-angle reverse faults, upthrown on the southwest side. The faulting is late Pennsylvanian in age and occurred over a long period of time, resulting in a much thinner sequence of Pennsylvanian sediments being deposited on the upthrown side. Maximum displacement may be as much as 4000 to 6000 feet (Hayes, 1964, p. 42), but appears to be about 1800 feet in the EIS study area. Kelley (1972) suggests that the Huapache fault zone may show left-lateral displacement.

Roughly perpendicular to the Huapache fault zone is a series of widely-spaced, subparallel northeast-trending normal faults. One of these is the Rock Tank fault, which cuts through the EIS study area. Displacement of the Rock Tank fault is about 700 feet. Both the Huapache and Rock Tank faults are Pennsylvanian in age, and die out without rupturing the overlying Permian formations.

The shallow structure of the area is expressed as a number of folds which appear to be late Tertiary in origin (Kelley, 1971, Plate 5S). The Huapache monocline is the result of Permian sediments draping over renewed movement of the underlying Huapache fault. A series of anticlines and synclines trend northeast, roughly parallel to the reef front. These gentle features are known as the Guadalupe Ridge folds and consist primarily of the Guadalupe Ridge anticline, Walnut syncline, and Reef anticline. The deeper structure, as mapped on top of the Middle Morrow Formation, is shown on Map 3-3.

Associated with the Tertiary folds is a conspicuous system of joints and fractures, termed lineaments, which parallel the fold axes, with less prominent fractures perpendicular to the main set (Jagnow, 1991). (See Map 3-4 at the back of this document).



Map of interpreted depositional environments and oil pools in southeastern New Mexico during Strawn time. Study area is outlined. (After James, 1985, p. 1060)

These fractures are especially important in the Dark Canyon EIS area, as they appear to be aligned with known cave passage orientations. Overall cave development in both Lechuguilla Cave and Carlsbad Caverns is strongly aligned east-northeast/west-southwest, parallel to these fold axes.

It is believed that oxygenated meteoric waters percolated through these fractures to mix with hydrogen sulfide (H_2S)-rich waters from depth to form sulfuric acid, which then excavated the major rooms of Carlsbad Caverns, Lechuguilla Cave, and other caves within the Guadalupe Mountains. The H_2S is believed to have originated from hydrocarbon deposits in formations of the Delaware Mountain Group in the basin and migrated updip into the reef in response to regional uplift, probably within the last three million years (Hill, 1990, p. 1692 - 1693). (A more detailed discussion of cave formation is found in the Cave Resources section of this chapter.)

Hydrocarbon Potential and Occurrence

Oil was first discovered in the Permian Basin in Mitchell County, Texas, in 1921. Since that time hydrocarbons have been produced from tens of thousands of wells in southeastern New Mexico, from formations ranging in age from Lower Paleozoic to Permian and from depths of over 15,000 feet to less than 100 feet.

In the vicinity of the Dark Canyon EIS study area, gas production has come primarily from Pennsylvanian-age formations, principally the Morrow, but has also included the Strawn, Atoka, Canyon and Wolfcamp. (Producing wells in this area are shown on Map 3-3 at the back of this document.) Table 3-1 identifies formations which may produce hydrocarbons from the drilling of the Diamondback well, and which could also be generally applied to the drilling of other wells within the EIS study area.

Development of the Dark Canyon EIS study area began in 1974 with the drilling of the #1 Lowe State (T. 24 S., R. 24 E., Sec. 16, 680'FNL & 1360'FWL) now renamed the #1 Maralo C & K State, which produced briefly from the Wolfcamp. Since that time a total of 24 wells have been drilled east of the Rock Tank Fault in T. 24 S., R. 24 E. All but three of these wells have had commercial production, exclusively from the Morrow and Strawn formations. Four wells have been drilled west of the fault in T. 24 S., R. 23 E., with only one producer (Morrow). Two wells have been drilled south of the Huapache fault, both dry.

The principal objective of the proposed Diamondback well is sand bodies of the Pennsylvanian Morrow Formation. The secondary objective identified in the applicant's geologic report is the Strawn Formation. The APD also lists the Canyon, Bone Springs, and Delaware as other possible hydrocarbon-bearing zones. An APD for a similar well - the #2 Serpentine Bends Unit, 1270' FSL &

455' FEL, Sec. 19 - was approved in 1979, as was an APD in section 30 for the #1 Serpentine OH Federal (1980'/N & 660'/E) in 1980. These APDs have been withdrawn and neither of these wells have been drilled.

TABLE 3-1

EXPECTED DRILLING TOPS IN THE DIAMONDBACK FEDERAL NO. 1

Depth	Elevation	Formation	Comments
0'	4316 GR	Seven Rivers	Perched aquifer @ appr. 76'
150'	4166	Queen	Potential cave passages
400'	3916	Grayburg	Potential cave passages
1000'	3316	San Andreas Reef	Potential cave passages
1187'	3129	Capitan Aquifer	Pot. water-filled passages
2285'	2031	Base Reef Complex	Base of Capitan Aquifer
2887'	1429	Delaware Pay Sands	Oil and Gas Potential
3337'	979	Bone Spring	Gas potential 5300'
7732'	-3416	Wolfcamp	Gas potential 8900'
9020'	-4704	Strawn	Gas potential]
9120	-4804	Atoka	Tight
9925'	-5609	Morrow Oolite	Tight
9960'	-5644	Morrow Sands	Gas potential
10,162'	-5846	Lower Morrow	Gas potential
10,400'	-6084	Barnet Shale	Tight
10,450'	-6134	TD (Total Depth)	

(**Source:** *"Cave and Karst Task Force Geologic Subcommittee Report,"* Jagnow, Cunningham and Bridges, 1991).

Portions of the EIS study area (all except sections 33, 34, and 35) were included as part of a large area classified as a Known Geologic Structure (KGS) in 1987 (Collar, 1987), based on a

regional study of Morrow Formation potential. Lands classified as a KGS were determined to have high potential for the existence of hydrocarbons by the BLM Carlsbad RMP/EIS (1986, p.3-6). All known production potential in the area is natural gas, with the nearest oil production located approximately ten miles to the northeast. However, no available drill stem tests from wells in or near the actual EIS study area have shown positive tests for oil. Nearby production has been primarily from the Morrow and Strawn Formations, although one well, the #1 Lowe State/#1 Maralo C & K State, apparently produced briefly from the Wolfcamp, as previously mentioned. No tests from other nearby wells have been positive in the Wolfcamp.

The closest well to the applicant's proposed location is the #1 Sidewinder (T. 24 S., R. 24 E., Sec. 20). Although this well is currently classified by the NMOCD as a temporarily abandoned oil well in the Delaware, the well is actually a very poor gas well and is clearly noncommercial. The initial potential test listed on the completion report filed with the NMOCD shows only 15 mcf of gas, no oil, and 122 barrels of water produced in 22.5 hours. No other production or positive indication from formations above the Pennsylvanian has been reported from the area. Ward, et. al. (1986), contend that hydrocarbons concentrated in Permian-age formations are found in channel clastics in the basin and in reservoirs developed at the interface between lagoonal carbonate and sabkha evaporite facies, which are located some distance shelfward from the reef margin. He states that "... immediate back-reef deposits do not furnish an adequate seal" (p. 261). Permian-age reservoirs located as close to the reef margin as the EIS study area are rare.

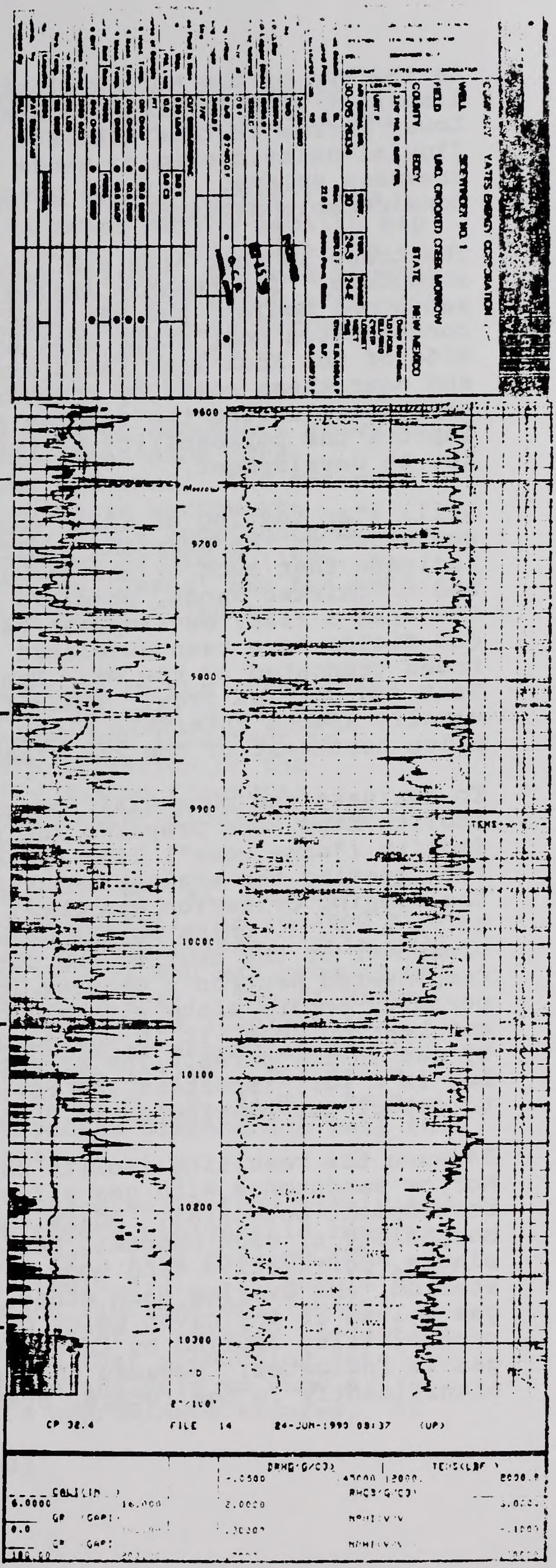
Therefore, hydrocarbon production within the EIS study area is likely to be limited to gas from the Morrow and possibly the Strawn; potential in other formations is considered to be low. Standard spacing for gas from the Morrow and Strawn is 320 acres per well. Standup or laydown orientation of each spacing unit is determined by the NMOCD on an individual basis, usually based on leasing pattern and occasionally on geology.

Morrow Potential

Within the EIS study area, the Morrow Formation is divided into three components, as shown on Figure 3-3. The Lower Morrow consists of sandstones, shales, and limestones and rests unconformably on the underlying Mississippian Barnett Shale. The Middle Morrow is marked by a prominent basal shale, called the Morrow Shale by James (1985, p. 1044), and consists of shales and sandstones. The top of the Middle Morrow is commonly referred to

WELL LOG OF #1 SIDEWINDER WELL SHOWING MORROW SECTION (From Schlumberger, 1990)

* = COMPANY PICK.



as the top of the Morrow Clastics. The Upper Morrow consists of limestone with interbedded shales and sands. The Middle and Lower Morrow in this area are interpreted to be primarily of fluvial-deltaic origin; sands represent channels, point bars, and crevasse splays. Several channel systems can be mapped for considerable distances.

The traps in this area are a combination of stratigraphy and structure. Impermeable shales confine natural gas in the sandstone bodies; the gas then tends to migrate updip, becoming concentrated near structural noses and on the upthrown (eastern) side of the Rock Tank fault system. Production is enhanced on and near these noses by fractures which formed in the brittle sandstones during the folding process. These fractures markedly improve the permeability of the reservoir rock and are often a key to development.

Drill stem testing of wells west of the Rock Tank fault and southwest of the Huapache fault system show little gas, and may indicate that much of the gas in those areas has migrated updip and to thicker sands, possibly leaving the western portion of the EIS area a risky development target. Several excellent Morrow gas fields have been developed on the east side of structural noses truncated by the Rock Tank fault system, including Rock Tank and Catclaw Draw. These fields are located at roughly equally spaced intervals along the fault, about six and fourteen miles northeast of the EIS study area.

To evaluate the potential for gas development in the Morrow, isolith maps were prepared for the Lower and Middle Morrow. An isolith ("same rock") line connects points of equal thickness of rock meeting the evaluation criteria. For the Morrow isoliths, the mapping criterion was total sand showing less than or equal to 70 A. P. I. units on the Gamma-Ray logs, while also showing crossover of the neutron and density porosity curves on Compensated Neutron - Density logs. "When an increase in density porosity occurs along with a decrease in neutron porosity in a gas-bearing zone, it is called gas effect. Gas effect is created by gas in the pores...The effect of gas on the Neutron - Density Log is a very important log response because it helps a geologist to detect gas-bearing zones." (Asquith, 1983, p. 68).

Because the resulting isolith maps depict total thickness of Morrow sandstones with gas effect, they indicate areas of development potential. While these maps are influenced by the morphology of each channel, bar and splay, they do not depict a single, correlative sand body. The sand bodies are multiple, stacked, and overlap each other. There is also no estimate of gas volume at any given point or guarantee of economic producibility implied by these maps--merely that the presence of gas is indicated. Because the price of gas may vary significantly in the future, predictions of likely development sites are primarily based on total thickness of gas-bearing sands, structural position, proximity to mapped lineaments and access.

The Lower Morrow in the EIS study area is predominantly limey, with very limited sand occurrence. The Lower Morrow isolith map (Map 3-5 at the back of the document) shows the area with gas accumulation to be thin, limited in areal extent, aligned roughly east-west, and located primarily north of the EIS study area. It appears that significant gas occurrence in the Lower Morrow within the EIS study area is unlikely, and that future development will concentrate on the Middle Morrow.

The Middle Morrow isolith (Map 3-6 at back of document) shows far greater thicknesses of gas-bearing sand, with much more widespread distribution in and near the EIS area. The general trend of the gas-bearing sand accumulation is northwest-southeast. This trend agrees closely with the location and orientation of a major channel system shown by James (1985, p. 1046). In the years since its publication, James' map has been proven to be very accurate in depicting major Morrowan depositional trends.

There are three major areas of accumulation in the area. These generally correlate to large thicknesses of sand which are located on structural noses. These noses are important to production in the area because of updip migration of the hydrocarbons and increased permeability due to fractures associated with the folds. Many of the better Middle Morrow wells in the area are located on noses.

The best well in the area, the #1 Franklin, et. al. Federal (T. 24 S., R. 24 E., Sec. 9, 660' FSL and 2235' FWL), is located at the thickest part of one of these major accumulations. This well has produced more than 4.9 bcf through 1/1/92 and may produce as much as 6.0 bcf before depletion (see Table 3-2). The #1 Ridge Federal (T. 24 S., R. 24 E., Sec. 23, 487'/N and 1620'/W) is located at the thickest part of a second major accumulation. This well has produced over 2.1 bcf through 1/1/92. The third major accumulation area is located in T. 24 S., R. 24 E., Secs. 18, 19 and 30, with the applicant's proposed Diamondback well in the best drillable spot to test the area.

Reservoir analysis of six productive Morrow wells from within and adjacent to the EIS study area show ultimate recoverable reserves ranging from 0.17 BCF to 6.3 bcf, with well life ranging from five years to possibly over 35 years (Table 3-2). It should be noted that gas pricing and market demand fluctuations, which began in the mid-eighties, have caused erratic monthly production volumes since that time. This requires that production data summaries be edited during decline curve analysis to show a clearer trend. As a result, these are approximate figures. It is reasonable to state that successful Morrow gas wells in the Dark Canyon area may typically have a well life of between 10 and 20 years and produce between 1.0 and 3.0 bcf of gas. There is a pronounced variation, however, and each individual well may be significantly better or worse than the norm.

TABLE 3-2

PROJECTED WELL LIFE AND ULTIMATE RECOVERABLE RESERVES FOR SEVERAL WELLS IN THE VICINITY OF THE EIS STUDY AREA:

FORMATION	**WELL LIFE***	**ULTIMATE RECOVERABLE RESERVES (BCFG)***
MORROW:		
#1 Franklin et. al. Fed. (24 S., 24 E., S. 09)	35+ yrs.	6.3
#1 Marathon St. Com. (24 S., 24 E., S. 11)	17.5yrs.	2.4
#1 Baldridge Canyon Com . (24 S., 24 E., S. 13)	16 yrs.	1.2
#2 Baldridge Fed Com. (24 S., 24 E., S. 14)	11+ yrs.	3.5
#1 Ridge Federal (24 S., 24 E., S. 23)	13 yrs.	2.2
#1 Chaparral OZ Federal (24 S., 24 E., S. 17)	8+ yrs.	0.17
STRAWN		
#1 Marathon State Com. (24 S., 24 E., S. 11)	14 yrs.	0.9
#1 Jurnegan State Com. (24 S., 24 E., S. 12)	5 yrs.	0.4

* The above figures were obtained by decline curve analysis of production data assuming exponential decline with a 1000 mcf/month economic limit. Wells were selected to provide a reasonable spread of geographic locations and productive potentials. Because of fluctuations in gas pricing and market demand beginning in the middle 1980's, monthly production figures became erratic at about that time; because the raw production data were edited for best curve fit, the above interpretations should be considered as approximate due to these variations.

(**Source:** Dark Canyon EIS Project Files, 1992.)

Strawn Potential

While there is no production from the Strawn Formation within the EIS study area at this time, the Strawn is being produced one mile to the northeast. Gas production is principally from massive, clean carbonates concentrated in sections 1, 11, and 12, T. 24 S., R. 24 E., and in several wells north and east of this township. This closest producing Strawn field to the EIS area is called Mosley Canyon. The Strawn carbonates occur as localized phylloid algal mounds distributed along the shelf margin.

Examination of petrophysical logs and DSTs from other wells in the area indicates that there may be some potential in the Strawn carbonates in the eastern portion of the EIS area, as well as limited potential from thin Strawn sands in the central portion of the area. Strawn potential does not appear to be great, and would be a secondary target of area development wells; any Strawn gas encountered in economic quantities would be produced after depletion of any Morrow gas.

The principal effect of any producible Strawn gas would be to extend the life of a well. Reservoir analyses of two of the wells producing from the Strawn carbonate (Table 3-2) indicate estimated ultimate recoverable reserves ranging from 0.4 to 0.9 bcf, with estimated life of the zone from five to 15 years.

CAVE RESOURCES

The most common method of cave formation throughout the world is by dissolution of carbonic acid. However, cave development in the Guadalupe Mountians, which includes the EIS study area is thought to be primarily from dissolution of carbonates from sulfuric acid. Isolated caves generally have formed in this area along the natural fractures that allowed the hydrogen sulfide (H_2S) to concentrate. It appears that only in the highly fractured portions of the Capitan Reef Complex have the various levels of cavern development evolved into huge cave systems, with Carlsbad Caverns having 24 miles of mapped passageways and Lechuguilla Cave with over 59 miles mapped to date. (Figure 3-2 at the back of this document indicates the formations and depths in which caves may exist.)

The current theory for the formation of these caves is that free H_2S gas and/or brines in combination with substantial amounts of dissolved hydrogen sulfide gas rose to the top of the Capitan Aquifer and combined with oxygen and water to form the sulfuric acid. The sulfuric acid then dissolved the limestone at the water table. The dissolved limestone was slowly carried away in solution, while gypsum and sulfur derived from the geochemical reaction remained in the newly-formed passages. Either as a result of the faulting that uplifted the Guadalupe Mountains, or because the water table dropped, the cave passages became air filled, while the process of dissolution continued at lower levels. Some of the gypsum that remained was dissolved and redeposited by dripping water into a wide variety of delicate cave formations, a process that continues today (Hill, 1987).

Because of certain physical attributes of caves, it may be possible in some instances to predict their size. By measuring the volume of air moving into and out of a cave during known barometric pressure changes, it is possible to estimate cave volume, and it is conceivable that the present known volume of a cave such as Lechuguilla is only a small fraction of the entire cave system. One study by the Lechuguilla Cave Project (Bruce Zerr, 1991) indicates that as much as 98 percent of this cave may still be undiscovered.

There are over 300 known caves in the Guadalupe Mountains, with potential for many additional caves with no known entrances. These mountains, and the caves within them, are highly significant for values related to geology, hydrology, mineralogy, archeology, paleontology, biology, recreation and scenery. Cave environments, by their very nature, provide unique, closed systems that are valuable for scientific study and environmental education of underground resources and the interrelationships between the surface and subsurface.

Many of the mineral formations found in these caves are very rare, extremely fragile, and are found only in these caves. Example of such formations include: subaqueous helectites, gypsum chandeliers, aragonite crystals, soda straw stalactites, gypsum flowers, hydromagnesite balloons and cave pearls. These formations, as well as the more common variety of cave formations, are irreplaceable in the context of human lifetimes.

Archeological and paleontological resources are preserved in the stable environments of caves, in near-perfect condition. The paleontological bone deposits found in the Guadalupe Mountain caves are valuable for the scientific study of late Pleistocene ecosystems in the southwestern United States.

Within the EIS study area there are six known caves. (Cave resources are shown on Map 3-7 at the back of this document.) The caves vary in length and depth, with the largest being Mudgetts Cave at over 3,000 feet of surveyed passage and the deepest being Big Manhole Cave, at over 100 feet deep. Big Manhole Cave is near the crest of the Guadalupe Ridge anticline with its main joint running parallel to the anticline. Large volumes of air flow from the loose rock in the bottom of this cave. The amount of air flow indicates the potential for an extensive system. Based upon air flow volumes, digging activities have been initiated in an effort to determine the extent of the cave.

There are three known caves located within CCNP adjacent to the EIS study area, the most notable of these being Lechuguilla Cave. Though the cave has been known since the early 1900's, it was not until 1986, after a series of digs occurred, that the main portion of the cave was discovered. (Map 3-7 shows the general location of Lechuguilla Cave and Figure 3-2 shows a cross-section of the known passageways of this cave.) Lechuguilla is at this time the 8th longest known cave in the world and is the deepest in the United States at 1,593 feet. At its closest point, passageways of this cave lie about 900 feet from the EIS study area and a little more than 1 mile from the applicant's proposed Diamondback well.

Lechuguilla is a world-class cave system that has spectacular features and is also important from a scientific research viewpoint. Many of the formations in the cave are considered as the finest examples of their type in the world, with Lechuguilla's subaqueous helectites being the only known example. A continuing study of the bacteria in Lechuguilla cave has led to a discovery of several species which oxidize sulfur as a means for obtaining energy, making this ecosystem a chemosynthetic environment. Most ecosystems are based on photosynthesis; chemosynthesis makes these bacteria relatively rare and important.

CAVE DETECTION METHODS

Three recent cave detection studies have been incorporated into this EIS to minimize the potential for intercepting and impacting undiscovered cave resources. These studies stem from a concerted effort made during 1991 by members of the Cave and Karst Task Force Oversight Committee and Technical Work Group. The participants included representatives from BLM, NPS, USGS, USFS, NM Oil Conservation Division, NM Bureau of Mines and Mineral Resources, Lechuguilla Cave Project, oil and gas industry, consulting individuals, and volunteers. These studies are explained below:

Lineaments: A substantial amount of work was done during 1991 by the Geology Subcommittee of the BLM Cave and Karst Task Force regarding the identification of lineaments (curvilinear or linear features such as faults and fractures) in and around the EIS study area and Lechuguilla Cave. The prominent fracture zones throughout the Guadalupe Mountains have provided many of the transmission points for hydrogen sulfide to form caves. Cavern development is most prominent at the intersection of these linear, near-vertical fracture zones.

Map 3-4 at the back of this document is a representation of the lineaments identified by the Geology Subcommittee. The lineament locations have been derived primarily from aerial photographs, with only a small portion of these lineaments having been "ground truthed" over Lechuguilla Cave. Although the existence of lineaments may be one of the best known methods for detecting likely locations of caves, a one-to-one relationship has not been established between lineaments and caves.

The lineaments identified on Map 3-4 represent fractured zones that are more soluble and transmissive of fluids than the adjacent areas. They also are potential points of focus for the dissolution over geologic time of cave passages by leaking H_2S. While the presence of a surface lineament may not always directly correlate with cave development below, they do indicate areas that are more susceptible to lost circulation and possibly cavern development. This is exemplified in lost circulation zones penetrated by several oil and gas wells drilled on or near lineaments.

Natural-Potential Method: The natural potential method is a geophysical method that has been used by industry to remotely detect buried ore bodies. An application of this method has been used to detect caves by measuring the earth's natural electrical current. The underground voids focus the earth's natural current, thus creating an anomaly over the cave.

During July 1991, the NPS contracted The Geophysics Group to conduct a natural potential survey over Lechuguilla Cave and portions of what is now the EIS study area. The purpose of the survey was to identify anomalies overlying Lechuguilla Cave and the surrounding area in order to provide a source of data about the possible location of fractures or cave passages.

Eleven lines of data were collected over four blocks within and adjacent to the EIS study area. These blocks were located along linements to maximize the likelihood of encountering an anomaly. The results of the survey identified anomalous features within each block. (The areas surveyed and the anomalies reported are shown on Map 3-8 at the back of the document.) The strongest anomaly is that shown in section 30, adjacent to CCNP, and is probably a fracture zone. This zone may include a shallow cave; however, it does not have the typical cave signature of Lechuguilla Cave. Another anomaly near the proposed Diamondback #1 well is not as well defined as most of the others identified during the study; it may express a fracture zone beneath the shallow alluvium of the area (Lange, 1991).

Helium Gas Study: On August 5, 1991, representatives from the BLM, NPS, USGS, and the Lechuguilla Cave Project, Inc., began a helium release experiment in Lechuguilla Cave. The purpose of the experiment was to identify any high permeability pathways that might extend from Lechuguilla Cave into the BLM back-reef within the EIS study area, so that the cave could be protected from oil and gas development. The detection of elevated helium concentrations at remote sample points on BLM lands could demonstrate a connection with Lechuguilla Cave on NPS lands.

The study was conducted by the release of a known volume of helium gas into Lechuguilla Cave, as a tracer, with attempts of tracking the gas as it diffused through the cave and out through the joints and fractures of the surrounding area. Prior to the gas release, sampling stations were established at prospective and producing well sites, along identified lineaments and over anomalies identified from natural potential data. Samples of the soil-gas were taken at each station (and continue to be taken as of the publication of this draft document). The surface sampling stations were 3-foot probes driven into the ground. The hollow probes would then have gas samples drawn out of them by a syringe and injected into an evacuated stainless steel cylinder and sealed. Samples were analyzed by the USGS laboratory in Denver, Co., using a mass spectrometer dedicated to mass 4 with a precision of +/- 10 ppb (parts per billion) by volume. (Map 3-9 at the back of this document identifies the sample points for the helium study.)

Although the report on the helium study is not complete, preliminary data suggest that the suspected mass transport rate of 60 feet/minute within Lechuguilla Cave occurs only in limited areas and that the actual migration speed of the gas is predominantly diffusion controlled and, therefore, much slower.

Also, the sampling at the helium monitoring stations was sporadic and may not provide the level of information originally envisioned.

However, since the beginning of the experiment and up to the writing of this document, large volumes of gas have continued to move from the helium release point in Lechuguilla Cave into a large northwest-trending lineament-aligned passage. This passage is referred to as the Northwest Passage and strikes towards the BLM-NPS boundary and the EIS study area.

No elevated levels of helium gas have been detected in the eastern portion of Lechuguilla Cave or at Big Manhole Cave. It may be that there is an air divide or break in the cave that prohibits air flow from one part of the cave to the other. In order to test the air flow to the eastern portions of the cave a second release of helium in the Far East section would be necessary.

The amount of helium gas entrained in the soil depends upon the amount of uranium and thorium in the rocks, which in turn depends upon the native rock type. The natural background helium concentrations in soils within the United States range between 5,160 and 5,300 ppb. However, petroleum reservoir rocks have extremely high concentrations of helium gas because of the effective retention of the gases by the trap itself over time. Three gas wells were sampled for helium concentrations prior to the helium release in Lechuguilla Cave: two on the east end of the EIS study area (Guadalupe Federal #1 and Ridge Federal #1) and one just north of the study area (Franklin #1). These wells averaged about 20,000 ppb helium concentrations.

Of the 23 helium monitoring stations, only 1 station, BLM #23 in section 20, east of the Sidewinder well (Map 3-9), had an elevated level of helium. The natural level of helium was measured at this location prior to the experiment. It was 5,220 ppb plus/minus 25 ppb. The measured helium level subsequent to the release was 5,682 ppb, an 8% elevation above the natural background level. (It is believed that helium measurements above 5,400 ppb would be a significant increase above the natural level.)

It was hoped that this study would quickly indicate whether lineaments and micro-fractures on the EIS study area communicate with Lechuguilla Cave. However, at this time, the results of the helium study are ambiguous, since only one of the 23 helium stations has recovered significant helium. The majority of the in-cave data suggest that most of the gas has migrated along joints and fractures (Cunningham, facsimile communication, 1992).

WATER RESOURCES

Dark Canyon, which runs through the EIS study area, is a major ephemeral tributary of the Pecos River with a watershed of approximately 450 square miles. The canyon begins high in the Guadalupe Mountains, entering the Pecos River near the city of Carlsbad. One of the water well fields supplying Carlsbad is located near the mouth of Dark Canyon. Throughout the EIS area the bed of the channel is wide and covered with large weathered stones. The channel is infrequently inundated by brief runoff events.

The only stream flow data available are from a USGS gaging station at the mouth of Dark Canyon, below the EIS area. The maximum discharge of record at this station was 27,000 cubic feet per second on September 26, 1980. The record shows many other large flows caused by thunderstorms. Aside from small springs, there are no perennial surface water sources in this area. The steep, rocky hillsides allow much of the rainfall to run off, quickly causing flooding in canyon bottoms.

Much of the recharge to the ground-water system comes from infiltration of these ephemeral flows through canyon bottoms. When there is flow in Dark Canyon, water levels in the Dark Canyon well field rise, and water from these wells can become turbid (Bjorklund and Motts, 1959). In addition, the City of Carlsbad Environmental Services Department has sampled city wells following runoff events and has documented increased levels of bacteria and turbidity in the water at those times.

The hydrology of the region is complex and incompletely studied. The water resources of Eddy County were described in general by Hendrickson and Jones (1952). Bjorklund and Motts (1959) defined the geology and ground-water hydrology of the region in greater detail, and identified the major aquifers, although their aquifer and water-level maps did not extend as far south as the EIS study area. Motts (1968) summarized the hydrology of the Guadalupian Reef Complex, and identified the presence of a very productive aquifer in the limestone reef complex, and less transmissive aquifers in the shelf-evaporite facies. The Capitan aquifer was defined by Hiss (1980) as including the Capitan and Goat Seep Limestones and associated carbonate rocks, including those in the upper part of the San Andres Limestone. The Capitan aquifer is bounded to the southeast by basinal facies that yield much less water, and to the northwest by the gradational change to lower-yielding rocks.

The Capitan aquifer is the principal water supply for the City of Carlsbad, Whites City, and neighboring communities. Near Carlsbad, the aquifer is very productive, with reported well yields of as much as 4,000 gallons per minute (Motts, 1968, p 289). The water resources of the area are regulated by the New

Mexico State Engineer, and the EIS study area is within the Carlsbad Underground Water Basin.

Northeast of, and overlying the Capitan aquifer are numerous perched aquifers, identified by Motts (1968) as perched water-bearing zones and by Hiss (1980) as shelf aquifers. Recharge in the Guadalupe Mountains occurs through direct infiltration of precipitation through the soil zone, and by stream losses during ephemeral flows following storms. Water moves downward until it reaches a less-permeable confining bed, usually a siltstone or shale interbedded with the limestone. The water then moves down the hydraulic gradient until it discharges to seeps or springs, or the alluvium of stream channels, or moves downward through or past the confining bed to a deeper aquifer (see diagrammatic section of Dark Canyon).

In the eastern part of the EIS study area an extensive perched-water zone is present in the Tansill Formation. This zone is maintained by the uppermost siltstone in the underlying Yates Formation. Water from this zone discharges to several springs in Juniper Canyon east of the area, including an unnamed spring in section 19, T 24 S., R 25 E., Light Spring, Cottonwood Spring, and Grapevine Spring. The springs emerge where the Yates Formation is exposed in the bottom of the canyon. The water levels in the perched aquifers and in the underlying Capitan aquifer are shown on Map 3-1. The contours show the altitude at which the water stands in wells open to these aquifers. The water moves approximately at right angles to these contours so that in the vicinity of the EIS study area, water in the perched aquifers is moving generally north or east, and water in the underlying Capitan aquifer is moving northeast.

Fresh-water circulation within the Capitan aquifer, and reactions with sulfide-bearing brine, have enhanced the water-yielding characteristics of the aquifer west of the Pecos River. Water levels near Carlsbad define an almost flat surface which rises only about four feet between Carlsbad and Whites City, a distance of 20 miles, attesting to the ease with which water moves through this segment of the aquifer. In the vicinity of CCNP, however, the surface probably becomes somewhat steeper, as shown on Map 3-10, from which it is inferred that the water-yielding properties of the aquifer are reduced. This steeper gradient is shown by the presence of the Lake of the White Roses in Lechuguilla Cave at an altitude of about 3130 feet. This lake is assumed to represent the altitude of the regional water level in the Capitan aquifer.

Additionally, a well that was drilled to supply water to the Guadalupe Federal #1 oil well, in Section 22, T24 S. R 24 E., reportedly had a static water level at about 1500 feet below land surface in the Capitan aquifer, at an altitude of about 3140 feet. Due to the absence of other wells penetrating the Capitan aquifer, the beginning of the steeper gradient cannot be located precisely: it is somewhere between Whites City and Lechuguilla Cave. Dissolution appears to have enhanced the water-yielding characteristics of the upper part of the Capitan aquifer more than the lower part. The change in water-level slope may occur at the intersection of the water table with the less-productive lower part of the Capitan aquifer.

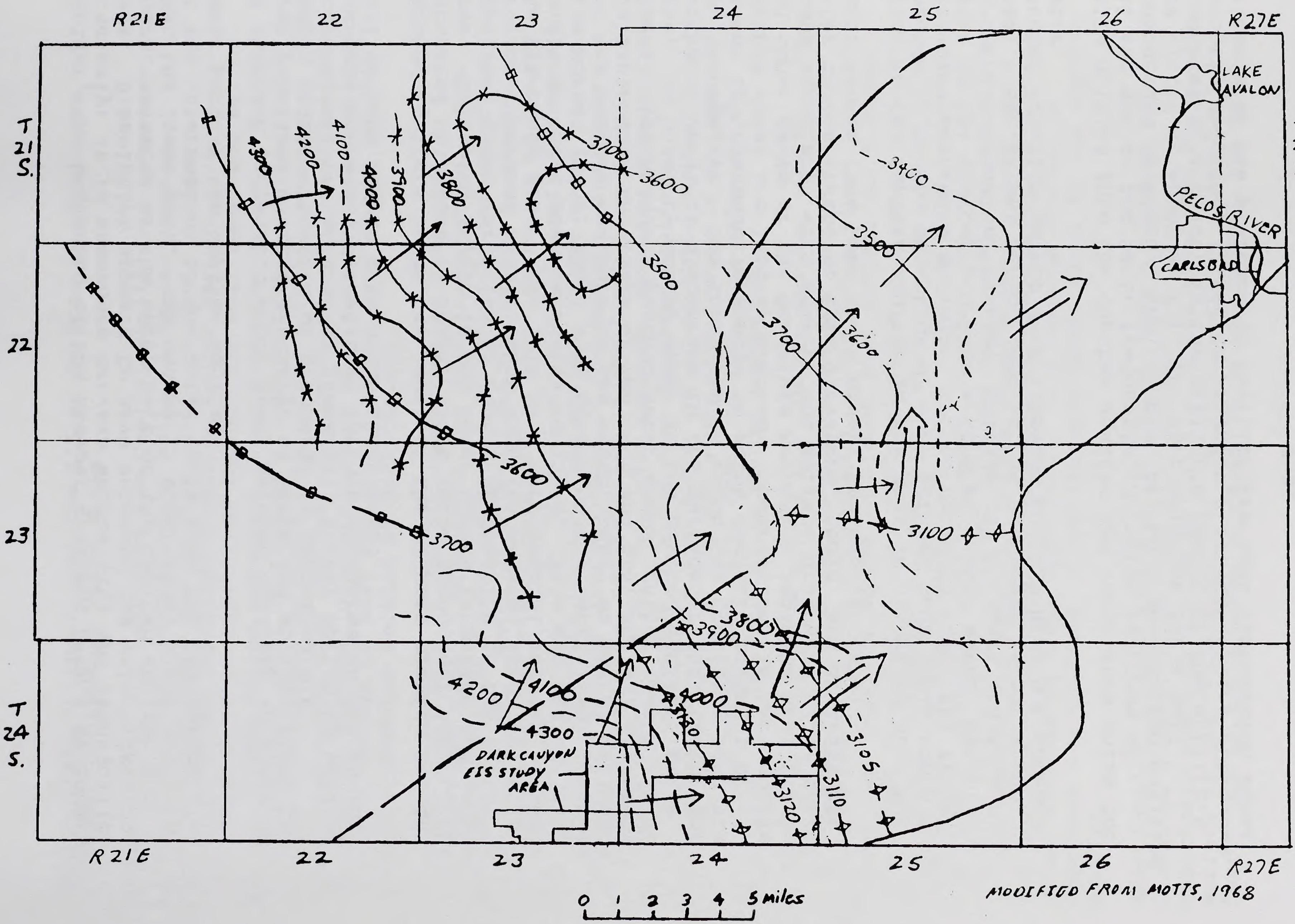
In the Dark Canyon EIS study area, perched aquifers in areas of deeply incised streams discharge as seeps and springs along the canyon walls. The rate of discharge is approximately proportional to the area of recharge. Turkey Spring as well as numerous seeps and wet-weather springs discharge on the south wall of Dark Canyon within the study area.

Perched aquifers below the level of the canyons provide enough saturated thickness to supply stock wells throughout most of the area. Confining layers in the Seven Rivers formation and in the uppermost Queen Formation at depths of from 120 to 225 feet provide a perched aquifer that supplies several stock wells in the EIS study area. Map 3-10 is a very generalized map of water levels in these more extensive aquifers. This map was modified from Motts' (1968) Plate 4 by extending the water-level contours for the perched aquifers to the south, based on sparse well data available from the files of the USGS and BLM, and may represent several discontinuous perched-water zones, rather than a single zone. As noted by Motts, water in the perched aquifers moves northeast until it discharges to the surface or infiltrates the Capitan aquifer. The locations in which the confining beds are absent or transmissive enough to allow downward movement of perched water are largely unknown. Observations in Lechuguilla and other caves of the Guadalupe Mountains indicate that fracture zones associated with some of the surface drainages allow enough water to infiltrate to form flowstone, pools, and at least one minor stream (the Lost Pecos River, Lechuguilla Cave).

Water in the Capitan aquifer in the area is generally hard but potable, with the exception of some perched cave pools containing excessive magnesium sulfate. In the Carlsbad area, the fresh water in the aquifer overlies a zone of saline water, sometimes containing dissolved hydrogen sulfide gas (Duchene and McLean, 1988). The extent of the zone to the southwest is not known. Perched aquifers in the area likewise contain hard but potable water.

Wells drilled into the Capitan aquifer and associated units for oil and gas or for water frequently encounter evidence of underground openings. (Wells which may have encountered cavities are listed in Appendix F.) The best evidence for a well encountering a cavity is the driller's report of the drill bit abruptly dropping, listed in Appendix F as "CA". More ambiguous evidence of the presence of cavities are lost circulation zones

Map 3-10



MODIFIED FROM MOTTS, 1968

WATER RESOURCES MAP
(MODIFIED FROM MOTTS, 1968)

Map 3-10 (Explanation)

EXPLANATION

Water Levels

Numbers are altitude, in feet above sea level, at which water would stand in a tightly cased well.

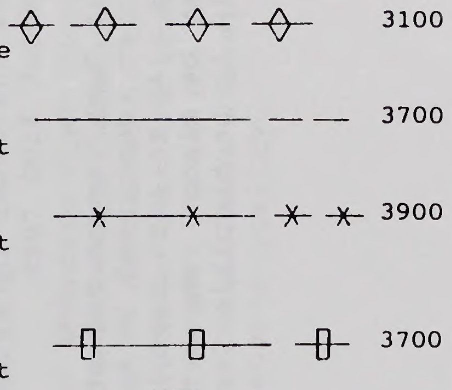
Broken lines indicate indefinite data.

Capitan Aquifer
  Contour Interval Variable

Perched Water-Bearing Zone
  Contour Interval 100 Feet

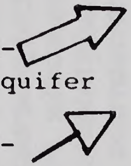
Perched Water-Bearing Zone
  Contour Interval 100 Feet

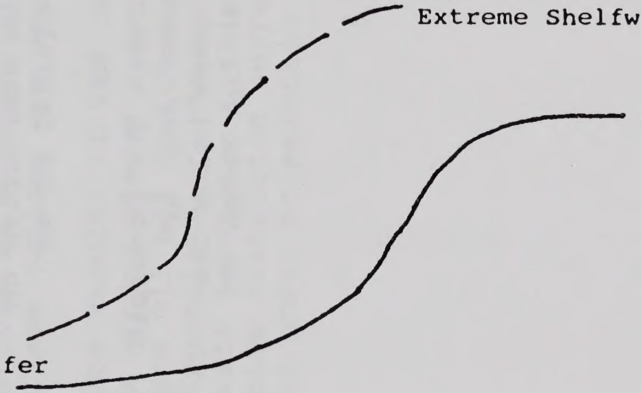
Limestone Aquifer Drains
Into Roswell Basin
  Contour Interval 1C0 Feet



Approximate Direction of Ground-
Water Movement in the Capitan Aquifer

Approximate Direction of Ground-
Water Movement in Perched Aquifers





Position of Capitan Aquifer
(From Hiss, 1976)

(LC), levels of the top of the cement (TC), and porous zones (PZ) identified on geophysical logs.

Drilling and cementing records of oil and gas wells sometimes report lost circulation zones, which can be either large cavities, a fracture zone, or a porous zone. Circulation may be lost through a small opening at the top of a fractured or cavernous zone, and the hole would be deepened with no return of drilling fluid. Thus, zones marked "LC" in Appendix F may or may not represent cavities, and if representing cavities, may be shallower than the cavity, or indicate only the shallowest in a series of cavities. When a casing string is cemented in the well, and the cement does not circulate to the surface, the top of the cement may indicate the location of a cavity or fracture, although the cavity may be below the top of the cement.

Borehole geophysical logs are usually not run through the cased interval in the Capitan aquifer, although some wells are logged with borehole-compensated neutron porosity and natural gamma logs. The zones of unusually large porosity, that do not have an associated higher level of natural gamma activity indicative of sandstones, may be a cavity. Porous zones can be identified on logs only below the water level in the Capitan aquifer at an elevation of about 3100 feet.

In and near the Dark Canyon EIS study area, evidence for possible cavities has been identified in Appendix F. These range in elevation from 2248 to 4404 feet, although the zones below the water table may be minor. These zones would span the range of solution levels in Lechuguilla Cave.

VISUAL RESOURCES

The canyon walls in the EIS study area feature vertical exposures of bedded limestone rising 600 feet from the canyon floor. The surrounding terrain is composed of deeply dissected limestone hills and rugged canyons. Slopes vary from two percent grade near the ridge tops to sheer cliff faces. The canyon and cliffs of Dark Canyon offer many scenic vistas and overlooks.

The Dark Canyon SMA lies totally within the EIS study area, designated as Class II or Class III for visual resource management (VRM) (shown on Map 3-11 in the back of this document.) These management prescriptions are designed to preserve the existing character of the landscape. The parts of the EIS study area that are designated as the more restrictive Class II, prescribe that the level of change to the characteristic landscape should be low and not attract the attention of the casual observer. Any changes must repeat the basic elements of form, line, color, and texture found in the predominant natural features of the characteristic landscape and should be substantially unnoticeable. (Visual Resource Mangement Class ratings are included in Appendix E.)

The results of VRM contrast ratings indicate that there would be a strong visual contrast between the existing landscape character and oil and gas development such as is discussed in the RFD (see Appendix A). The Carlsbad RMP prescribes that the area around well locations within the Scenic Area portion of the SMA shall have restricted surface disturbance to minimize visual impacts, in order to maintain the Class II scenic quality.

SOCIAL AND ECONOMIC CONDITIONS

Zone of Influence

The affected environment for the applicant's proposed action and alternatives described in this EIS covers Eddy County and the cities of Carlsbad and Artesia. A majority (perhaps 80%) of the jobs generated and expenditures made during the exploration and development of the petroleum resources in Dark Canyon would be in this area (pers. comm., Bill Baker, 3/23/92). In addition, rentals, royalties and taxes generated by the development will impact federal, state and local revenues.

Similarly, any impacts to the tourism industry related to CCNP would be felt mainly in Eddy County, especially the city of Carlsbad. Virtually all of the employees at CCNP reside in Carlsbad and the surrounding area, most supplies for the park are purchased locally, and most of the money spent by visitors to the park are spent in the immediate area (NPS news release, 2/16/88; pers. comm., Bob Crisman, 3/23/92).

Population

In 1990, the population of Eddy County was estimated to be 48,605. The population of the county has been fairly stable for the last ten years, having grown only 1.6 percent between 1980 and 1990. The majority of the inhabitants are concentrated in the cities of Carlsbad (26,119) and Artesia (10,610). Table 3-3 shows how the population of the county has varied since 1950.

Employment and Income

The estimated civilian labor force in Eddy County in 1991 was 21,333, of which 19,882 were employed, resulting in an unemployment rate of 6.8%. Since 1988, labor force and employment have increased, while the unemployment rate has dropped. Table 3-4 is a summary of these changes. Non-agricultural employment was 16,982 in 1990, with services and misc. (3,694, 22%), wholesale and retail trade (3,540, 21%) and mining (includes oil and gas) (3,216, 19%) employing the largest number of people. Table 3-5 shows the breakdown of non-agricultural employment by industry sector.

Per capita personal income in Eddy County was $13,496 in 1989, compared to $11,972 in 1988 and $11,263 in 1987. Median family income was $26,200 for fiscal year 1990. Total personal income in 1988 was $562.5 million, an increase of 5.2% over the previous year. In 1990, total non-agricultural wages were approximately $334 million, with mining (which includes oil and gas) ($97 million, 29%), government ($55 million, 16.5%) and services and misc. ($51 million, 15%) paying the largest fractions of total wages.

Characteristics of the Economy

Oil and Gas Industry: Production of oil and gas is very important to the economy of Eddy County. In 1990, Eddy County ranked second in oil production and fourth in natural gas production among New Mexico counties. Marketed production of oil totaled 14,456,000 barrels valued at $320,205,000. Approximately 62 percent of this production was from federal lands. Natural gas sales amounted to 165,502,000 mcf, valued at $287,959,000. Approximately 65 percent of this production was from federal lands. An average of 1,207 people were employed in the industry, and earned total wages of $32,306,229 in 1990. This represents 7.1% of the total employment, and 9.7% of the total wages in Eddy county. Additional statistics for the oil and gas industry in Eddy county for the years between 1980 and 1990 are given in Table 3-6.

In 1991, federal oil and gas revenues collected in Eddy County amounted to $58.2 million, representing 90% of the federal revenues for all minerals collected in Eddy County, and 25% of the total federal mineral revenues collected in the state of New Mexico. Fifty percent of this revenue is returned to the state. Table 3-7 shows federal mineral revenues in Eddy County for the years 1988 through 1991. In addition to its share of the federal royalty, New Mexico collects excise taxes of 8.05% on oil and 8.5% on gas, as well as ad valorem taxes at a rate 1.5% on oil and gas.

Tourism: The lodging industry and eating and drinking industry are indicators of the contribution of tourism to the local economy. In 1990 these industries had gross receipts of $31.7 million, employed 1,296 and paid wages totalling $8.2 million. This represents 7.6% of total employment, and 2.5% of total wages, in Eddy County. Table 3-8 gives a summary of statistics for the tourism industry.

In 1991 there were 679,450 visitors to CCNP, 90% of whom are non-local. It has been estimated that expenditures by these non-local visitors, in the form of lodging, meals and transportation, amount to $29 million. A majority of visitors (536,787) toured Carlsbad Caverns. Another 126,634 people viewed the other attractions in the immediate vicinity of the main caverns and visitors center, mainly the bat flight and the Walnut Canyon Desert Drive. Away from the main caverns, the most popular attractions were the Rattlesnake Springs picnic area (7,317), New Cave (7,098), and other wild (undeveloped) caves within the park (1,170). A total of 443 permits for backcountry use were issued by NPS in 1991, of which 161 were for overnight stays. Additional statistics for Park visitation for the years between 1980 and 1991 are given in Table 3-9.

In addition to the contributions made by direct tourist expenditures, Carlsbad Caverns injects approximately $3 million into the local economy through its operating and improvements budget. The NPS has about 90 permanent full time employees and 50 temporary or seasonal employees at Carlsbad Caverns.

TABLE 3-3

EDDY COUNTY POPULATION AND FUTURE ESTIMATES

Year	**Population**
1950	40,600
1955	47,200
1960	50,800
1965	48,000
1970	41,10
1975	42,600
1980	47,855
1986	51,900
1987	49,900
1988	48,800
1990	48,605
1995	47,700
2000	48,500
2005	48,900
2010	49,363

(**Sources:** U.S. Census Bureau, UNM-BBER, 1990 and 1991.)

TABLE 3-4

CIVILIAN LABOR FORCE ESTIMATES
EDDY COUNTY-ANNUAL AVERAGES

Year	**Civilian Labor Force**	**Employment**	**Unemployment**	**Unempl. Rate**
1988	20,370	18,459	1,911	9.4%
1989	20,330	18,765	1,565	7.7%
1990	20,464	19,088	1,376	6.7%
1991	21,333	19,882	1,451	6.8%

(**Source:** NM Dept. of Labor, 1991 and 1992.)

TABLE 3-5

NON-AGRICULTURAL EMPLOYMENT, WAGES AND WEEKLY EARNINGS--1990

Industry Sector	Employment		Wages ($000's)		Weekly Earnings
Total	16,982	100.00%	333,981	100.00%	
Manufacturing	739	4.35	22,581	6.76	588.21
Mining	3,216	18.94	96,764	29.04	589.20
(Oil and Gas)	(1,207)	(7.11)	(32,306)	(9.67)	514.94
Construction	777	4.58	11,658	3.94	288.45
Trans. and Pub. Utilities	1,583	9.32	43,559	13.04	553.92
Wholesale Trade	464	2.73	9,973	2.99	413.80
Retail Trade	3076	18.11	32,687	9.79	204.35
(Eating and Drinking)	(863)	(5.08)	(4,955)	(1.48)	110.45
Fin., Ins. and Real Estate	624	3.67	10,901	3.26	351.45
Services and Misc.	3,694	21.75	50,615	15.16	285.05
(Lodging)	(433)	(2.55)	(3,279)	(0.98)	145.62
Government	2,809	16.54	55,242	16.54	385.85

Note: Industry sectors shown in parentheses are part of the previous sector, eg. oil and gas is part of the mining sector.

(**Source:** NM Dept. of Labor, 1991.)

TABLE 3-6

EDDY COUNTY OIL AND GAS PRODUCTION AND VALUE

	Oil		Gas		
Year	Production (Barrels)	Value ($)	Production (MCF)	Value ($)	Employment
1980	16,043,948	390,682,965	212,477,413	414,421,186	1,359
1981	12,308,917	431,348,394	212,323,942	478,322,824	2,242
1982	10,523,916	335,350,252	196,346,786	489,372,059	2,277
1983	9,911,430	292,617,592	166,001,204	446,578,947	1,842
1984	10,353,824	301,326,394	179,641,637	477,029,189	1,801
1985	11,421,713	305,479,946	155,390,107	397,438,672	1,847
1986	11,226,717	168,931,918	114,179,184	202,559,575	1,266
1987	10,500,344	187,062,236	119,455,954	193,223,637	1,095
1988	10,637,919	158,297,612	131,333,219	222,532,523	1,135
1989	12,165,122	214,381,292	152,704,039	252,616,550	1,166
1990	14,456,219	320,206,233	165,501,465	287,958,617	1,207

(**Source:** New Mexico Energy, Minerals and Natural Resources Dept., 1981-1991.)

TABLE 3-7

EDDY COUNTY FEDERAL MINERAL REVENUES

	1988	**1989**	**1990**	**1991**
Bonus, All Minerals	2,445,070	6,670,960	5,224,951	4,632,370
Bonus, Oil and Gas	2,445,070	6,670,439	5,224,951	4,632,128
Rental, All Minerals	1,167,507	1,447,699	1,223,320	2,050,479
Rental, Oil and Gas	663,943	897,482	713,799	764,228
Royalty, All Minerals	32,154,069	35,659,343	42,832,744	57,231,244
Royalty, Oil and Gas	28,868,100	31,721,990	39,021,738	52,820,807
Total, All Minerals	35,766,646	43,778,002	49,281,016	63,914,092
Total, Oil and Gas	31,977,114	39,289,911	44,960,488	58,217,163

(**Source:** Minerals Management Service, 1988-1991.)

TABLE 3-8

EDDY COUNTY TOURISM, 1990

Employment	1,296
Lodging	433
Eating and Drinking	863
Wages($000s)	8,234
Lodging	3,279
Eating and Drinking	4,955
Gross Receipts ($000s)	31,743
Lodging	8,792
Eating and Drinking	22,942
Lodger's Tax Receipts (FY'90, $000s)	6,670
Carlsbad	257
Artesia	49

(**Source:** New Mexico Economic Development Dept., 1991 and New Mexico Dept. of Labor, 1991.

TABLE 3-9

CARLSBAD CAVERNS NATIONAL PARK VISITATION

Year	**Total**	**Cavern Entry**	**Other Visits**	**RS Sprs**	**Back Ctry. Day/Night.**		**New Cave**	**Wild Caves**
1980	672,960	NA						
1981	771,766							
1982	781,963							
1983	712,247							
1984	712,989							
1985	732,482							
1986	752,552							
1987	781,300							
1988	786,135	523,682	247,129	8,153	912	351	5,861	47
1989	792,378	537,870	241,205	6,498	203	115	6,034	649
1990	747,016	517,507	211,812	9,715	248	147	6,541	1,045
1991	679,450	536,787	126,634	7,317	282	161	7,098	1,170

NA: Data not available

(**Source:** National Park Service, 1991 and 1992.)

WILDERNESS

Approximately 2,100 acres of the 2,941 acre BLM Mudgetts Wilderness Study Area (WSA) lies within the study area. (See Map 3-12 in the back of this document.) This BLM WSA was not recommended for wilderness designation. Congress may be making a decision on New Mexico wilderness designations within the next 2 or 3 years. The NPS administers designated wilderness lands in CCNP contiguous with the EIS study area boundary on the south.

The proposed Diamondback location and well 3 of Alternative A lie about 1/2 mile to the west of the WSA boundary. Wells 2 and 4 lie about 1.2 miles to the west of the WSA. Well location 5 would lie within the WSA in section 23 and wells 6 and 7 would lie within 500 feet of the WSA boundary in section 24. This well location could not be drilled until Congress decides on wilderness or non-wilderness designation for the Mudgetts WSA. Because this location would lie on a post-FLPMA lease, it is subject to the "nonimpairment criteria." (BLM Wilderness Handbook H-8550-1.)

CULTURAL RESOURCES

From man's first arrival in the Southwest about 10,000 B.C. to the final subjugation of the native population in the late 1800's, southeastern New Mexico was inhabited by aboriginal hunters and gatherers who subsisted on various wild plants and animals found in the region. These people found a number of edible plants throughout the area including mesquite beans, hackberries, walnuts, acorns, seed-producing grasses, agave, and a variety of other succulents. Big and small game, including bison, deer, antelope, rabbits, reptiles, birds, and various invertebrates were hunted or collected in the region.

From about A.D. 600 onward, as trade networks were established with Puebloan peoples to the west, domesticated plant foods and materials including corn or maize, beans, squash, and cotton were acquired in exchange for dried meat, hides, and other products from the Pecos Valley and Plains. The indigenous population may also have practiced horticulture at favorable locales in the area, but only on an intermittent basis, since water for crops would have been scarce and unpredictable much of the time.

In the mid 1500's, the Spanish Conquistadors encountered Jumano and/or Apachean peoples in the region practicing hunting and gathering and engaging in trade with Puebloans like that described above. Later, as the natives acquired horses and as Europeans began settling the land, this traditional lifeway evolved into specialized bison hunting on the Llano Estacado and raiding both Spanish and Puebloan settlements to the west. When the Indians were forced onto reservations in the late 1800's, the region was settled by American ranchers and farmers.

In the western part of the Carlsbad Resource Area, most of the cultural sites consist of burned rock middens, rock art locales, and caves and rockshelters containing perishable artifacts, along with occupational debris such as stone projectile points, cutting and scraping tools, pottery fragments, vegetal grinding tools, and burned rock from hearths. These sites represent the occupations of hunters and gatherers who utilized the plants and animals in the Guadalupe Mountains and foothills west of the Pecos River.

Historical sites known consist of early 20th century homesteads that failed to prove up or isolated features from late 19th and early 20th century cattle and sheep ranching and military activities. Although the area was part of the Spanish and Mexican colonial empires, no related conquest or settlement sites have yet been identified.

Previous cultural resource inventories within the EIS study area are limited to ten surveys done for oil and gas concerns in Dark Canyon (well pads and lease roads), an earth dam and stock tank location in Dark Canyon, a well pad and pipeline route in Stone Canyon in the northern part of the study area, and two stock watering facilities and a seismic monitoring station on Guadalupe Ridge, in the eastern part of the project area. Each of these inventories was limited in scope, examining linear corridors 100 feet in width and of varying lengths, or small blocks of less than four acres each. Almost all of the inventory work has been limited to the floors of Dark Canyon and Stone Canyon, with some smaller projects on surrounding slopes, such as the inventory for the Diamondback Federal #1, and the seismic monitoring station and the stock watering facilities on Guadalupe Ridge. No archeological or historical properties were recorded in conjunction with these projects.

Cultural resource inventory work completed immediately surrounding the EIS study area has resulted in the discovery of numerous cultural properties, particularly to the south in CCNP. Topography, soils, bedrock, vegetation and other environmental characteristics in the surrounding CCNP areas are comparable to those in the EIS study area, and should have provided nearly identical settings for prehistoric and historic usage.

Sites on record for the areas surrounding the EIS study area are most frequently prehistoric in age. The majority are marked by succulent plant roasting features which appear as mounds or ring-shaped accumulations of burned rock, charcoal, and other burned organic materials, and discolored soils. These midden features are generally set in a larger, diffuse camp or activity area which can include patterned arrangements or accumulations of burned rock, ground and flaked stone tools and debris, ceramic sherds, and occasionally other materials or features. Other site types noted in the vicinity include rockshelters with evidence of prehistoric occupation, and sites marked by pictographs or painted rock art panels, sometimes in association with occupational debris. Historic components are occasionally noted and include features and debris related to ranching, particularly sheep ranching, in the early years of the 20th century. In addition, much of the modern ranching debris and facilities in the locality appear to date to the 1940s and 1950s.

Informally-known cultural resource sites include burned rock middens within or adjacent to some of the previously inventoried areas on the floor of Dark Canyon. The majority of the sites recorded in adjacent areas, and of the several sites known within the EIS study area but not yet recorded, typically include elements which can contribute to their eligibility for the National Register of Historic Places. For the most part, the cultural properties known and anticipated for the EIS study area are significant, must be identified and assessed through inventory, and must be considered in any plan of development for the area.

SOILS

The four major soil delineations within the area are Limestone Rockland, Ector Stony Loam, Ector Extremely Rocky Loam and the Dev-Pima Complex. The Limestone Rockland makes up approximately 50% of the area, while the two Ector soils each comprise about 25% of the acreage. All three of these soil types fall within the Limestone Hills CP-4 range site.

The Limestone Rockland consists of 60-90% outcrops on the surface, which is mainly thin-bedded limestone with some sandstone, siltstone, and shale. The land features include steep to very steep canyon walls and escarpments, highly dissected by stream erosion. Most of the drainages are intermittent channels. The soil material, where it occurs, is stony or rocky loam, with little or none on the steeper slopes. Plant roots are limited to the soil between rocks and in small pockets on sloping areas. Runoff is rapid to very rapid, water holding capacity is very low, and there is little or no surface water. These areas are difficult to cross using ordinary transportation.

Vegetation includes gramma, muhly and three-awn grasses, sotol, agave, cacti, ocotillo, and algerita. Scattered pinon, juniper, and mountain mahogany can be found at the higher elevations where more precipitation occurs. Revegetation is difficult due to limited soils and undependable precipitation.

Both Ector soils fit the series profile, being very shallow to shallow, well-drained, calcareous, stony and extremely rocky loams over limestone bedrock. They are found on nearly level to gently sloping areas on ridges and mesa tops. They also occur on side slopes. The soil profile is a stony loam to a depth of about six inches, underlain by limestone. This limestone is often exposed at the surface. There is little to no surface water, except briefly, following infrequent high intensity short duration rainfall. Runoff is rapid after the soils become saturated, permeability is moderate and the water holding capacity is very low to low. These soils are subject to water erosion if the vegetation is lost; however, the many stones and rocky outcrops help stabilize the level to gently sloping areas.

Proper management of surface uses is needed in these areas in order to maintain vegetative cover, allowing continued stability of the soil profile and putting a check to soil erosion potential. Revegetation is difficult in these soils as well, due to the undependable precipitation occurrence.

The Ector Stony Loam is a fertile soil, but is limited both by the shallow depth of the limestone bedrock and the high density of rocks and stones overlain on the surface. Erosion can be severe once the vegetation cover is lost. Exposed bedrock and catsteps occur on 20-50% of the surface of Ector Extremely Rocky

Loams. These outcrops have many vertical and horizontal cracks cross-sectioning all or portions of their surface. Vegetation for these Ector Series soils include gramma and muhly grasses, beargrass, sotol, agave, ocotillo, broom snakeweed, creosote, and yucca with occasional junipers occurring at higher elevations.

The access road and pipeline alignment generally would be located on Dev-Pima soils. The Dev series soils are soils developed in alluvium that are nearly level, moderately dark colored, and gravelly. They occur on flood plains of intermittent streams, adjacent to hills and mountains. These soils are underlain by very gravelly and cobble material many feet thick. The Dev series soils typically have a grayish-brown gravelly loam surface layer about 3 inches thick. A second layer is also a grayish-brown gravelly loam. Loamy soil material begins at a depth of about 15 inches and is mixed with gravel and cobblestones, which account for about 60 to 90% of the soil mass. The Dev series soils make up about 50 to 65 percent of the soils along the road and pipeline alignments.

The Pima series soils are deep, well-drained, moderately dark colored, calcareous soils developed in alluvium from limestone parent material. These soils are typically light brownish gray silt loam in the upper 3 inches, with a brown or light-brown silty clay loam below.

The Dev-Pima soils are subject to erosion by water and are periodically flooded. Permeability is moderate (0.2 to 2.5 inches per hour) above the very gravelly material. The water-holding capacity is low as is the natural fertility of these soils. The corrosivity to untreated steel pipe is moderate. The shrink-well potential of the soil is low.

The suitability of the Dev soils for topsoil is poor because of the gravel and cobblestones intermixed with the soil. For the Pima soils, the topsoil suitability is fair to poor, due in part to erodibility. As with the Ector soils, the limited topsoil present is well protected by vegetation and rocks. As road fill, the Pima soils are poor; the Dev soils are fair with careful site selection. The suitability of both the Dev and Pima soils for pipeline installation is limited because of periodic flooding and shifting stream channels, moderately slow permeability, and possible conflicts with high water tables.

VEGETATION

Native vegetation in the area has been influenced by the effects of both man's activities and natural occurrences, including livestock grazing, man-made structures, recreation, wildland fire, and drainage. Four habitat types occur along the east Guadalupe escarpment (Standard Habitat Site Descriptions For The Carlsbad Resource Area [SHS's]) of which all could be affected by the proposed action. Briefly, these are:

PIÑON/JUNIPER GRASS MOUNTAIN

This habitat type is found at the higher elevations, on ridge tops and to some extent, in the heads of drainages. Predominantly, this type occurs along the Lincoln National Forest boundary in isolated pockets.

The dominant aspect is of piñon pine and one-seed juniper with sparse to medium dense grass cover of *Bouteloua* spp., *Muhlenbergia* spp. and *Aristida* spp. Mountain mahogany, Oaks, Rabbit bush, Sumac and *Opuntia* spp. are typically present with several annual and perennial forbs represented.

MIXED SHRUB HILL

Dominant species are *Acacia spp.*, *Mimosa biuncifera*, *Condalia ericoides*, Apache plume, Sumac with local representation of succulents including *Yucca* spp., *Nolina* spp., *Agave* spp., and cacti. Clumps of grama grasses (*Bouteloua* spp.) are common. Additional typical shrubs are Broomsnake weed, Honey mesquite, Creosote bush, *Dalea formosa*, *Aloysia wrightii*, *Parthenium incanum*, and American tarbush.

This type is typical of the side slopes and ridge tops cross-sectIng the escarpment, generally acting as the transition zone separating drainage bottoms (Zero-Riparian type), and between alluvial flats (Grass Flat type) and higher ridge tops where the Piñon/Juniper type dominates.

ZERO-RIPARIAN

Defined as drainage or arroyo with perennial water flow supporting vegetation non-characteristic of surrounding uplands. Grass and forb species are often sparse. Typical shrub and tree species are desert willow, netleaf hackberry, Apache plume, soapberry, little-leaf sumac, maple, oak, little walnut, *Baccharis* spp., honey mesquite, ash and *Brickellia* spp. This type dominates the drainage and canyon bottoms along the escarpment.

GRASS FLAT

Grass flats are usually low swales and consist primarily of grass species. The dominant being tobosa grass. Others are vinemesquite, gramma grass, muhly grass, burrograss, alkali sacaton, and lovegrass. Some areas are entirely of alkali sacaton. Shrub species are found in low numbers with soaptree yucca being most common along with broom snakeweed, American tarbush, honey mesquite and all-thorn. This type dominates the lower alluvial bottoms and swales adjacent to the lower foothills of the Guadalupe escarpment.

WILDLIFE

INTRODUCTION

The east Guadalupe escarpment is representative of the Chihuahuan desert ecosystem, supporting those wildlife species associated with the Chihuahuan desert. Typical wildlife species represented within the EIS study area include mammals such as mule deer, coyote, mountain lion, gray fox, a variety of rodents and other furbearers, avian species such as raptors, passerines and upland game birds, and various types of herpetofauna.

MAMMALS

Yearlong, game species, primarily deer, are common in Dark Canyon, due in part to the proximity of CCNP, which serves as a de facto wildlife refuge. Predominantly, this country is desert shrub with scattered areas of piñon/juniper. These habitat sites include a 10-15% shrub composition with important deer browse species such as mountain mahogany, sumac, wavyleaf oak, apache plume, and fourwing saltbush.

Mule deer is probably the most visible mammal type occurring along the Dark Canyon drainage and surrounding east Guadalupe escarpment. Scattered bands (2-20 animals) occupy all parts of the escarpment during times of dependable precipitation. When drought conditions prevail, the herds move into areas where a permanent water source (livestock waters, wildlife watering units, springs, natural catchments, etc.) is available. These water sources are highly important and irreplaceable resources, supporting large concentrations of deer during the dry months of the year and during extended drought periods, sometimes lasting several years. The New Mexico Department of Game and Fish (NMDGF) indicate the deer habitat is in a stable condition with herd numbers stable or slightly increasing. Aerial surveys were flown in January 1991, by the NMDGF with BLM biologists as observers. The results were 11 bucks : 100 does : 64 juvenile in Big Game unit 30 (as designated in NMDGF Hunting Proclamation). More specifically, the ratios were taken from the NMDGF study area, which starts in the upper reaches of Dark Canyon at the Forest boundary. Within the Roswell District, Big Game unit 30 overall supports the greatest buck to doe ratio within Hunt Unit N, with the exception of the Duncan/Piñon area. Barbary sheep are persistent in the area in small numbers, but are seldom seen.

Various predator/furbearer species also occur prolifically along the Dark canyon drainage. The presence of mountain lions has been reported and substantiated, based on studies of radio-collared lions by the NMDGF. Other species such as the coyote, bobcat, racoon, badger, ring-tail, skunk (3 species), kit fox, gray fox, and porcupine occupy all habitat sites occurring along the escarpment. As with all mammalian species, especially within desert ecosystems, year-round water is a necessity for survival, thus concentrated populations of these animals occur around the water sources.

Rodents constitute possibly the largest and most diverse group of mammals occurring along the Guadalupe Mountain range, their numbers fluctuating based on annual precipitation, predator densities, and grazing duration and intensity. Observations of animal sign support the listing of Botta's pocket gopher and the ringtail (not a rodent) as common mammals inhabiting the ridge tops along Dark Canyon.

Two members of the order Lagomorpha are present along the escarpment as well, the black-tailed jack rabbit and the desert cottontail rabbit. Their numbers fluctuate, as with rodents, according to annual precipitation and predator densities, and to some extent, grazing intensity.

(Appendix D lists mammals within the Dark Canyon ACEC based on a survey conducted by The Nature Conservancy (TNC) in January of 1990.)

BIRDS

Dark Canyon is home to a highly diverse population of birds, with the largest group of that population being the passerines. Many species of this group occupy the Guadalupe escarpment and associated Dark canyon drainage year long, yet other species of the group are migratory, and utilize the area only seasonally. The list of normally occurring birds, combined with migrants and wintering species, exceeds 200 species. Of note are some of the rarer species, including the Bell's vireo, cave swallow, golden eagle, and white-throated swift.

Nevertheless, whether seasonal or year-long occupants, populations are concentrated around water sources. As with many avian species, free standing water is not always a necessity, however, the insect biomass and diversity in habitat created by a free standing water source (whether natural or man-made) are highly influential in attracting and sustaining the avian populations. Year-long occupants become very dependent on the water-based benefits. Appendix D lists birds occupying the Dark Canyon ACEC as reported by TNC. Predominantly, the avian species occupy the drainage bottoms or "Zero-Riparian communities" due to the diversity in cover and nesting habitat.

HERPETOFAUNA

Few species of snakes and lizards were identified by TNC during their inventory in Dark Canyon (see Appendix D). According to TNC, the presence of populations of Texas banded gecko, crevice spiny lizard, Trans-Pecos rat snake and black-tailed rattlesnake is highly probable; a sighting of a black-tailed rattlesnake has been documented in the area. It is likely, according to TNC, that 16 to 20 species, or more, could be found in the area. (Appendix D lists Herpetofauna within the Dark Canyon ACEC.)

MOLLUSKS

As documented in the Dark Canyon ACEC biological inventory, no detailed study was made of the mollusks that occur in the Dark Canyon ACEC area due to time constraints. Stock tanks were checked for Physa virgata which is an ubiquitous species at such watering places. None were found. The arid conditions that exist throughout the study area are not conducive to a vibrant mollusk population, and only one species was found. Other likely species include Pecosorbis kansasensis, a snail that until recently was federally and state listed as an endangered species. Pecosorbis originally was known as a fossil from the Pliocene (Taylor, 1985). It was suspected to exist in historic times, and eventually living individuals were found in 1972 (Smartt, 1987). Studies by Smartt eventually resulted in the discovery of many new additional sites for this species and it was delisted. It is known from nearby portions of CCNP and probably occurs in the EIS study area.

Additional species that might be expected in this area include Ashmunella carlsbadensis, Holospira montivaga and Retinella indentata. Only one species was found in this study area, Rabdotus dealbatus.

WILDLIFE HABITAT IMPROVEMENTS

The one habitat improvement existing along the upper reaches of Dark canyon in the SENW of section 30 is the Serpentine Bends earthen dam. This project was solely funded through the Sikes Act habitat improvement program. This program was initiated in 1987, and consists of collecting a $5.25 fee from all hunters, trappers and fisherman utilizing the area in order to implement wildlife habitat maintenance and/or improvement measures. The earthen dam was placed in a location where it would derive the greatest benefits for wildlife through maximized distribution of water. Cost of the project totaled approximately $5,000.00.

SPECIAL STATUS SPECIES

There are a number of special status species which potentially occur throughout the Dark Canyon drainage and outlying adjacent lands, based on surveys conducted by TNC on three special management areas (SMA). Two of these SMAs the Lonesome Ridge ACEC and the South Texas Hill Canyon RNA encompass the same standard habitat sites as those occuring within the EIS study area (the third SMA being the Dark Canyon ACEC).

An overall list of special status species for the EIS study area was compiled using several references, including TNC inventories from the Lonesome Ridge ACEC, South Texas Hill Canyon RNA, Dark Canyon ACEC, list of federally-endangered species of New Mexico (March 21, 1990), amended listing of endangered wildlife of New Mexico (November, 1990), handbook of species endangered in New Mexico (1990), and list of federal candidate category 2 species of New Mexico (June 1991). This overall list is included below:

PLANTS

Thread-leaf false carrot *Altes filifolius*--state sensitive
Chaplin's columbine *Aquilegia chaplinei*--state endangered
Lee's pincushion *Coryphantha sneedii* var. *leei*--federally threatened/state Endangered
Sneed pincushion *Coryphantha sneedii* var. *sneedii*--federally endangered
Turk's head cactus *Echinocactus horizonthalonius*--state sensitive
Button cactus *Epithelantha micromeris*--state endangered
McKittrick pennyroyal *Hedeoma apiculatum*--federally threatened
Cliff nama *xylopodum*--state sensitive
Five-flowered rock daisy *Perityle quiqueflora*--state sensitive
Chinquapin oak *Quercus muhlenbergii*--state sensitive
Supreme sage *Salvia summa*--state sensitive
Hedgehog cactus *Echinocereus pectinatus*--state sensitive
Guadalupe milkwort *Polygala rimulicola* var. *rimulicola*--state endangered
Rosa stellata--state sensitive and federal candidate (category 3)
Twistflower *Streptanthus carinatus*--state sensitive
Texas tobacco root *Valeriana texana*--state sensitive
Viola viarum var. *guadalupensis*--state sensitive
Hershey's cliff daisy *Chaetopappa hersheyi*--state sensitive and federal candidate (category 2))
Pincushion cactus *Mammillaria heyderi*--state sensitive
Penstemon *cardinalis* spp. *regalis*--state listed

(Map 3-13 in the back of the document illustrates locations of special status species of plant populations within the Dark Canyon ACEC. Adjacent areas outside of the ACEC have not been surveyed for special status plants. However, the potential exists for special status occurrence throughout the entire escarpment.)

MAMMALS

Swift fox Vulpes vecox--federal candidate (category 2)
Guadalupe southern pocket gopher Thomomys umbrinus guadalupensis--federal candidate (category 2)

BIRDS

Southwestern willow flycatcher Empidonax traillii extimus--federal candidate (category 2)
Varied bunting Passerina versicolor--state endangered
Bell's vireo bellii--state endangered
Gray vireo vicinior--state endangered
Mexican spotted owl Strix occidentalis lucida--proposed for listing
Ferruginous hawk Buteo regalis--Federal candidate (category 2)
Peregrine falcon Falco peregrinus--Federally and state endangered

(**Note:** Several historical records of Peregrine sightings have occurred in Carlsbad Caverns National Park to the south.)

HERPETOFAUNA

Gray-banded kingsnake Lampropeltis mexicana--state listed (specific status unknown)
Western ribbon snake Thamnophis proximus--state endangered
Mottled rock rattlesnake Crotalus lepidus--state endangered
Texas horned lizard Phrynosoma cornutum--federal candidate (category 2)

CHAPTER 4
ENVIRONMENTAL CONSEQUENCES

CHAPTER 4
ENVIRONMENTAL CONSEQUENCES

INTRODUCTION

This chapter provides the scientific and analytical basis for the selection of the preferred alternative. Significant impacts anticipated to result from the implementation of each alternative discussed in Chapter 2 are covered here. Both beneficial and adverse impacts affecting the environmental components described in Chapter 3 have been analyzed. Discussion of impacts is proportional to the anticipated significance; if impacts are not discussed, the analysis determined that impacts either would not occur or would be insignificant. None of the alternatives would have significant impacts on topography, climate, natural history or fire. A summary of impacts by alternative (Table S-1) is included in the Summary of this EIS.

The causes of an impact are tied to a component of one of the alternatives, as identified in Chapter 2, while the effects of an impact are tied to a component of the environment described in Chapter 3. Because of the design features (mitigation) built into the alternatives to minimize environmental impacts, the impacts assessed in this chapter are considered to be unavoidable. If irreversible or irretrievable impacts are not discussed in a given section, there are none. Cumulative impacts were based on incremental actions from foreseeable development over time.

Extensive knowledge of the EIS study area and professional judgement, based on observation and analysis of similar conditions and responses in similar areas have been used to infer environmental impacts where data are limited.

ALTERNATIVE A
THE PROPOSED ACTION AND CONVENTIONAL DRILLING OF WELLS WITHIN THE EIS STUDY AREA

OIL AND GAS RESOURCES

The drilling and subsequent production of the wells under this alternative would result in the production of hydrocarbon reserves in the near future as opposed to the reserves remaining as a resource. The gas produced within the study area could amount to 25 billion cubic feet (bcf) of gas with a value of $32 million. Royalties to the federal government (of which 50% goes to the State of New Mexico) would be approximately $4 million.

Residual impacts on oil and gas resources would include normal lease and reservoir maintenance, possible recompletion to shallower zones as lower zones are depleted, and eventual plugging, abandonment and reclamation of the affected lands.

Cumulative Impacts - The Dark Canyon EIS study area and vicinity has been the site of gas development since 1973, when the #1 Lowe State was drilled in Section 16, T. 24 S., R. 24 E., and in 1974, when a Morrow test, the #1 Dark Canyon State, was drilled in Sec. 26, T. 24 S., R. 23 E., approximately 6.25 road miles further upstream from the applicant's proposed location. Since that time a total of 30 deep wells have been drilled in T. 24 S., Rgs. 23 & 24 E., with six wells drilled within Dark Canyon itself. Full-field development would result in the drilling of up to eight additional deep wells in the EIS study area. Three wells are likely to be located in the eastern end of the EIS study area in a separate Morrow/Strawn play (see Appendix A, RFD). The estimated life of the field is 20 - 30 years, depending on the presence of Strawn gas, rate of drilling, and individual well performance.

CAVE RESOURCES

Data from wells drilled within the EIS study area indicate that two broad zones of lost circulation occurred between the surface to 450' and between 1100' to 1200' (see Table 4-1). These zones coincide with two of the seven major solution levels in Lechuguilla Cave, with the strongest correlation at the 1100' to 1200' levels (see Table 4-2 and Figure 3-2). Lost circulation zones may be evidence of the existence of voids encountered during drilling.

If a void were encountered at any depth during drilling within the EIS study area, the primary initial impact would be the loss of circulation (partial or complete). Drilling fluids, (e.g., water, additives, lost circulation material, cuttings, and mud) would be pumped under pressure into the void. It would be customary for an operator to continue drilling without returns coming back to the surface until the desired depth for setting casing is reached.

In the first 350 feet of drilling, fresh water would be used, so the primary substance entering a cave would be cuttings from the drilling. If drilling is not stopped if a cave passage were encountered, the water and cuttings would continue to flood the cave until the lost circulation was under control. At depths below 350 feet, depending on the type of void encountered, mud constituents, length of drilling time, and extent of lost circulation, the drilling fluids would flood the cave passage or void that were encountered. The volume of contaminants could range from a few hundred barrels to several thousand barrels of cuttings and drilling fluids in a mostly freshwater solution.

The impact of this type of flooding would cause the breakage of formations, disruption of cave sediments, contamination of micro-organisms in the cave, and possible localized changes in chemistry of nearby sediments and secondary deposits. These chemical changes could affect the growth or dissolution of speleothems (cave formations).

Drilling into a cave, even without the impacts of drilling fluids, cement and lost circulation materials, would adversely affect the cave. The delicate equilibrium between barometric pressure, temperature and humidity in a cave can be altered by a bore hole, whether or not the cave has a natural entrance to the surface. Speleothems, any cave micro-organisms present, and other natural processes would be altered. The creation of a new opening to the surface would cause changes in the air flow patterns in the cave during the time that the hole was open. These air flow changes would create unnatural temperature and humidity regimes altering the microclimate of the cave, possibly causing the reduction of formation growth, the drying out of cave formations, and destruction or alteration of micro-organisms.

If a cave passage or void were water-filled, drilling fluids would be introduced. The void would fill completely or be plugged with cuttings, causing circulation of drilling fluids to return to the surface after a few hours or days of drilling. It is presumed that the loss of circulation materials into a dry void would be of more significance than if the void were water-filled.

The use of lined mud pits throughout the RFD could cause incremental contamination of the cave environment by leaching chemicals after the pits were broken and allowed to dry. Leaching of chemicals could also occur due to leaking flowlines, gas dehydrators and tanks. The chemicals and other constituents could change the chemical composition of the minerals forming speleothems and adversely alter the cave atmosphere. This chemically-altered atmosphere could cause the deterioration of existing formations and/or prevent their natural growth.

During completion, when the well casing is set to the desired depth, a mixture of cement and additives would be pumped down the casing, and then back up outside and around the casing to form a protective sheath of cement between the casing and the well bore. If voids have been encountered and there is a loss of circulation, the cement mixture would enter a portion of the void and remain there permanently. This volume could amount to as much as several hundred cubic feet of cement, the total volume of the annulus.

The impacts from cementing voids becomes more important if a very large, dry cave passage were encountered. In such cases, thousands of cubic feet of cement could be pumped into the void to ensure a cement sheath is formed around the steel casing. Pea gravel or cementing chemicals would be pumped around the casing and into the void, with additional cementing following for remedial work. When gravel is used, the integrity of the cement sheath can be impaired. The cement and pea gravel form a concentric core around the casing from the bottom of the void to the top of the void, ensuring the formation of a cement sheath. In such cases, a portion of the void would be permanently filled with cement and gravel.

In a worst case situation during the drilling, completion, and production of a well, natural gas could migrate into caves, or fractures and voids which lead to a cave, and contaminate them. If natural gas were to flow through an open hole or through casing/cement that either failed or was inadvertently perforated, the gas would follow passages or other routes, such as small fractures or faults, and eventually contaminate a cave or cave system. The risk to humans from the migration of gas could be substantial. Explosions could result when the gas and oxygen in the cave mix and are ignited by carbide lights often used by cavers. The replacement of oxygen by the gas endangers humans by asphyxiation.

Cave values would be damaged by explosion. The presence of hydrocarbons, even in small amounts, could change the delicate balance of the cave atmosphere, causing the rapid deterioration of cave formations and the disruption or death of cave life.

After a well was depleted and then plugged and abandoned, impacts to cave values could also occur if explosive or poisonous gases leaked into a void or fracture which communicated with a cave. This could occur as a result of deterioration of casing over time and/or an ineffective cementing operation during completion of additional wells. The steel casing may deteriorate over time because of actions on the casing from natural elements.

However, once a well is depleted of its production and "killed" with heavy muds, the pressures are considerably reduced in the borehole. An analytical determination (Appendix F) indicates that it is unlikely that large quantities of brines would move upward into the Capitan aquifer (and cave formations) from the deeper producing formations. If hydrocarbons were released into the borehole, they would be entrained in the borehole fluids and probably not have enough pressure to invade fractures or voids which may communicate with a cave. Therefore, it appears that the risk and rate of movement of hydrocarbons in the event of failed casing or cement in a plugged and abandoned well would be limited.

Also, the increase of traffic resulting from oil and gas exploration and production could result in more unauthorized cave use and greater potential for vandalism in caves.

Summary

Drilling fluids, cuttings or cement that would enter voids or cave passages would not be recovered. In the case of small voids, the voids would be plugged. In the case of a cave, a passage or room could be partially or completely plugged, most likely by cement or a mixture of cement and gravel.

The cumulative impacts for developing a natural gas field based on the RFD of 8 well locations could have negative effects for both caves and cave environments. The lineament surveys, natural potential surveys, and helium study indicate high porosity and permeability and a potential for major cavern development within the EIS study area.

The drilling, completion, production and abandonment of multiple well locations increases the probability of impacting cave resources. The potential for impacting cave resources from drilling fluids, cement, hydrocarbons, and leaching of chemicals into cave ecosystems increases with each well drilled. These impacts become significant when considering the long term effects on known and undiscovered caves from successive wells that are drilled, produced, and abandoned over time.

Long-term impacts of leaky casings due to corroded pipe or poor cementing could allow hydrocarbons to leak into the cave systems and cause permanent damage to the environment and cave resources, possibly causing death to recreationists from explosions or asphyxiation. Also, the increase of traffic resulting from oil and gas exploration and production could result in more unauthorized cave use and greater potential for vandalism in caves.

TABLE 4-1

LOST CIRCULATION ZONES FROM BALDRIDGE CANYON WELLS

(Tops of zones at feet below surface elevation.)

Well Name	T/R/Sec.	Elev.	1st	2nd	3rd
#1 Guadalupe Federal	24/24/22	4643	239	418	1120
#2 Baldridge Federal	24/24/14	4242	--	--	--
#1 Baldridge Canyon	24/24/13	--	1230	--	--
#5 Lechuguilla Canyon	24/24/15	--	122	160	--
#1 Ridge Federal	24/24/23	4639	300	455	--

(**Source:** Cave and Karst Task Force Geologic Subcommittee Report--Jagnow, Cunningham and Bridges, 1991.)

TABLE 4-2

PRIMARY SOLUTION AVERAGE LEVELS IN LECHUGUILLA CAVE

Feet Below Entrance	**Elevation**	**Comments**
150	4490	Entrance passages above Boulder Falls, Wooden Lettuce Passage
645	3995	Top of main cave intermediate levels, Lechy's Lair, Underground Atlanta, Tower Place, Ghost Town area, Firefall Hall
733	3907	Topmost levels of the Far East (Grand Guad. Jct.), top Chandelier Maze
5	3825	Chandelier Graveyard, H-Survey/Aragonitemare Pit area, many areas
950	3690	Void and Ruby Chamber water lines, Western Borehole
1100	3540	Top 1st Outback level
1255	3380	Lower Outback Area

(**Source:** Cave and Karst Task Force Geologic Subcommittee Report--Jagnow, Cunningham and Bridges, 1991.)

WATER RESOURCES

Surface disturbance associated with development of eight potential well sites (roads, pads, pipelines) within Dark Canyon would increase soil erosion locally. The increase in mechanical activity associated with this development may also add chemical constituents to the surface soils. Floods may allow chemical contaminants, including salts and hydrocarbons not degraded in the soil zone, to infiltrate the groundwater system. Mud pits on the surface may also contaminate ground water.

Drilling in the Dark Canyon EIS study area could affect both the perched aquifer and the underlying Capitan aquifer. Potential groundwater impacts from drilling can be divided into those caused:

1) during drilling and cementing,
2) during testing and production, and
3) following plugging and abandonment of the well.

Effects During Drilling

The top 350 feet of the well would be drilled with fresh water and cased prior to drilling deeper. Thus, the quality and quantity of water in the perched aquifer should not be significantly affected. If lost-circulation zones, either air- or water-filled, were encountered above the confining unit, some cement could be introduced into shallow caves adjacent to the borehole. In the saturated zone, cementing would temporarily increase the pH of the water adjacent to the wellbore.

The unsaturated zone in the upper Capitan aquifer, below the lowermost confining layer in the overlying unit, would be affected by drilling fluid if lost-circulation zones were encountered. Fresh water, bentonite (gel), or other organic constituents such as cedar fibers or paper sweeps used to stop lost circulation or clean the hole would be introduced. Lost fluids would either be ponded locally, or move downward to the water table. Materials introduced above the water table in karst systems may remain immobile for indefinite periods only to move under conditions of increased recharge.

Some of the soluble materials introduced would move to the water table. Lost circulation zones at or below the water table would allow the introduction of drilling fluids directly to the zone of saturation in the Capitan aquifer. The introduction of fresh water with limited drilling mud or organic material may have an effect on the local microbiology, but is unlikely to have a significant impact on water quality. Cementing the intermediate casing string through the upper part of the Capitan aquifer would introduce cement into any cavities encountered, but the effect would be limited to the immediate vicinity of the wellbore. Below the water level, the effect would be limited to a local slight increase in the Ph of water near the wellbore.

Effects during Testing and Production

The quality of water in the perched aquifers could be affected by drilling fluids, reserve pit material, hydrocarbons or other contaminants that may be released to the surface during testing and production. The use of steel lined pits would mitigate this potential except in the case of accidents. Some organic constituents may be degraded in the soil zone, but inorganic constituents, principally sodium chloride, would be leached to the perched aquifer and increase the dissolved solids content. Such a release could result from accidents during drilling and production or from damage to equipment including the pipeline during flash floods.

If the inner and intermediate casing strings were to rupture following installation, drilling fluids, brine, or gas could be released directly to the subsurface anywhere along the casing string. Drilling fluids or brine would move down to the water table, and then down the hydraulic gradient as shown in Map 3-10. Gas released in the unsaturated zone between the confining layers in the perched aquifers, or between the lowermost confining layer and the water level in the Capitan aquifer, would diffuse through the air-filled part of the unsaturated zone. The confining layers which limit the downward movement of water would likewise limit the upward movement of gas, keeping the concentrations higher in the zone where continuous confining layers are present.

Effects Following Plugging and Abandonment

Because the atmosphere in the unsaturated part of the Capitan aquifer contains elevated concentrations of carbon dioxide and trace amounts of sulfur compounds as well as oxygen, in zones not protected by cement the steel well casing would slowly become corroded and eventually fail. Heavy drilling mud in the intermediate casing would move into any cavities present, and its constituents would eventually be leached to the water table. If the casing and plugs in the overlying confining units fail, water would leak downward from the perched aquifer to the Capitan aquifer. In the unlikely event that the plug fails completely, the water level in the perched aquifer would be lowered to the elevation of the confining layer at the well site. This effect would be similar to that of a continuously pumping well and could eventually reduce the water levels and production in nearby stock wells, depending on the local properties on the water-yielding zone.

The effects of the failure of plugs below the water table in the Capitan aquifer was examined by evaluating drill-stem tests from nearby oil and gas test wells (Appendix F-1). Although there are uncertainties in the calculation of water levels and temperatures, it appears unlikely that large quantities of brine would move into the Capitan aquifer from the underlying units if there were a casing failure.

When the well is killed with cement, plugged and abandoned, any gas seepage would have to diffuse through or around that column. Because the pressure in the producing zones would be reduced through production, it is unlikely that large quantities of gas would migrate through the plug.

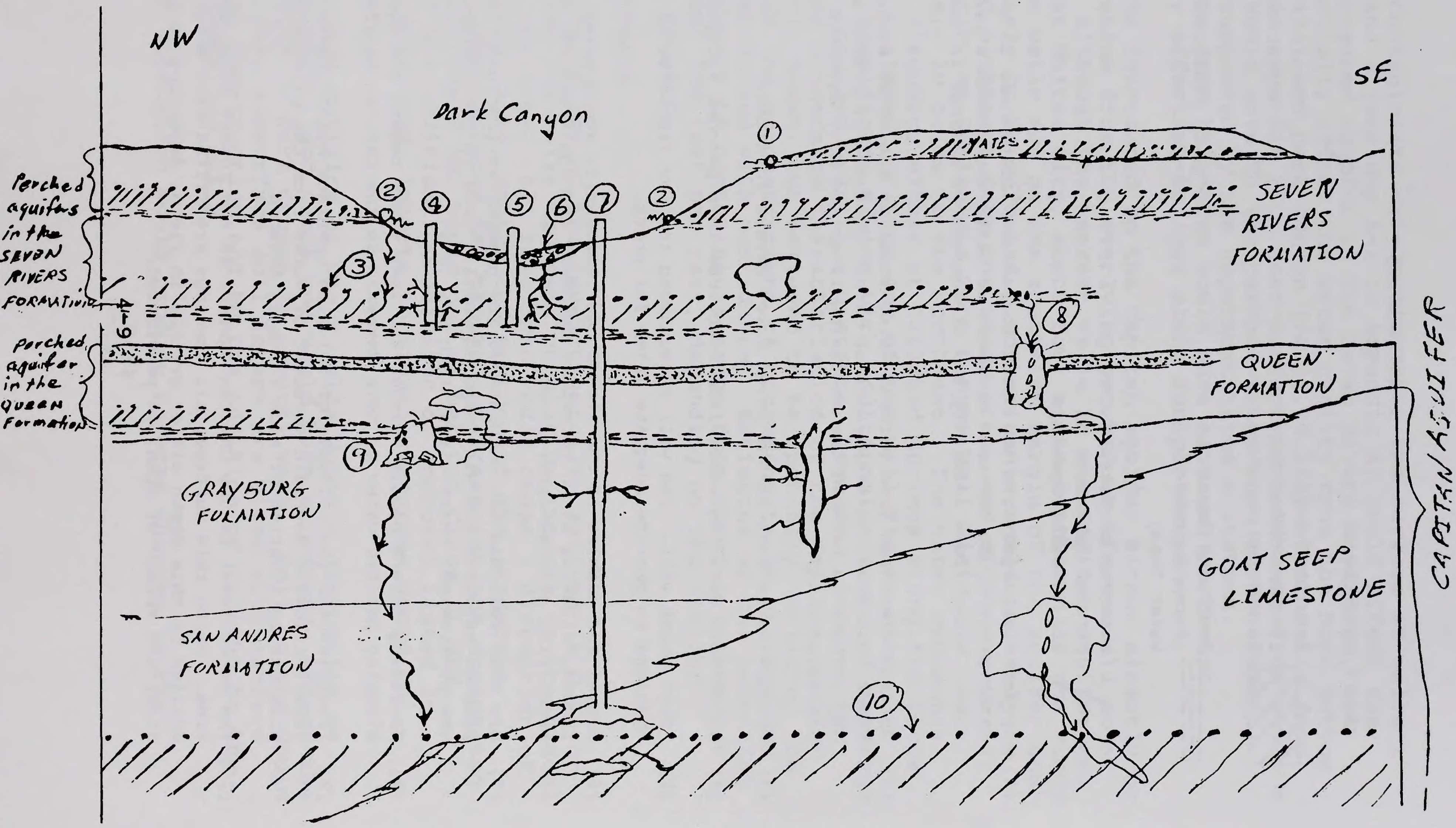
Movement of Contaminants

Cumulative impacts would involve the movement of contaminants from the drilling, production, and casing deterioration of wells over time. Mobile contaminants introduced into a perched aquifer would most likely move northeastward down the hydraulic gradient (Map 3-10) until they either discharged to the surface at a spring or infiltrated the Capitan aquifer (see Figure 4-1 for a probable diagrammitc section of the water resources within the

Figure 4-1

PROBABLE DIAGRAMMATIC SECTION OF DARK CANYON

(From EIS team files, 1992)



(not to scale)

EXPLANATION

●●●●● Water Level

▨ Saturated Zone (Perched-Water Zone in Perched Aquifer)

– – – – – Confining Layer (Forms Perched-Water Zone)

↘ Movement of Water Through Fractures and Solution Openings

Spring

Cave (Solution Opening)

Fractures

(1) Spring discharges from the Yates Formation. Siltstones in the basal Yates prevent the downward movement of water and create a perched-water zone. Water flows laterally and discharges as springs in small tributary canyons.

(2) Springs discharge from perched-water zones in the Seven Rivers Formation. Water that does not evaporate, or is not consumed by plants and animals, may infiltrate between the confining layer and move downward to the next saturated zone.

(3) Perched-water zone in the lower Seven Rivers Formation.

(4) Stock well deriving water from fractures in a perched aquifer.

(5) "Dry" stock well. The well encountered too few fractures or solution openings to provide adequate water for stock.

(6) Gravel and cobbles in the stream bed temporarily store water following floods, allowing it to percolate downward through fractures to the underlying perched-water zone.

(7) Dry test well has not encountered any productive fractures in the perched acquifer and was deepened until a cave in the Capitan Aquifer was penetrated, where circulation was lost.

(8) Confining layers become thinner and less silty toward the southeast, allowing perched-water to move downward to the Capitan Aquifer.

(9) Fractures and the collapse of solution openings might breach confining layer, allowing downward movement of water from the perched zone. The presence or location of such zones is unknown.

(10) The water level in the Capitan Aquifer is the lowest water level in the area. Below this surface, all openings are filled with water. Wells drilled to this depth differ greatly in yield, depending on the number, size, and extent of openings penetrated.

canyon). Contaminants originating near the surface at wells 1 through 4 and 8 (see Map A-1 in Appendix A) would affect the lowermost perched aquifer in the Seven Rivers Formation, and could potentially affect the water quality from the Rock Bottom (24.24.19.434) and Dark Canyon (24.24.20.243) stock wells (see Table F-2 in appendix F). Near-surface contaminants from wells 5 through 7 would move to the perched-water zone in the Tansill Formation supported by the uppermost Yates siltstone. Contaminants from this area would move east and northeast, potentially affecting springs along Juniper Canyon.

Contaminants introduced to the Capitan aquifer either directly or by infiltration from the overlying perched aquifers would move northeast. Although the nearest wells in the Capitan aquifer are the wells at Whites City, about four miles southeast of the study area, these wells are on the southeast margin of the aquifer and are not likely to be affected. Contaminants would probably be transported northeast from the study area, and might eventually reach the City of Carlsbad's Dark Canyon Well Field, approximately 20 miles to the northeast. The water would eventually discharge either at Carlsbad Springs along the Pecos River near Carlsbad, or from one of the well fields near Carlsbad. Significant mixing with additional sources of recharge would have occurred over this distance, however. Because the porosity and dispersion characteristics of the Capitan aquifer are so poorly known, but believed to be spatially variable, the travel times and concentrations of contaminants in the aquifer cannot be predicted with confidence. Estimates of the potential rate of movement of contaminants range from about 2 inches per year to about 900 feet per year, depending on the aquifer properties assumed.

VISUAL RESOURCES

The selection of any of the development alternatives (A,C,D, or E) would have basically the same cumulative impacts on the visual quality of the area. All locations would cause a disruption of the basic form, line, color, and texture of the landscape character. The Carlsbad RMP management prescriptions designated for the Dark Canyon SMA would not be met for Class II VRM. However, if the additional conditions of approval listed in Appendix E were used, impacts to visual resources would be mitigated.

In general, the drilling of the 8 wells would a disruption of soils, vegetation, and slope and would have an adverse effect the visual quality of Dark Canyon in several ways. Soil colors would be changed when subsurface soil layers are mixed with surface soils during construction and by the addition of caliche to the naturally occurring soils.

The loss of vegetation would produce adverse changes in the visual character of Dark Canyon by creating distinct lines where vegetation has been removed and by changing the texture of the landscape. Landscape form would be temporarily affected by the presence of the drilling rig. The form of the landscape would also be altered by the presence of production facilities if the wells were producers. The line of the landscape would change from curvilinear to straight due to the earth work for pad and facility construction. Cumulative impacts would increase with the construction of additional pipelines and roads.

In addition to the eye-attracting motion of the heavy truck traffic servicing the developing gas field, this traffic would also cause large amounts of dust to become airborne, with the sounds being audible for a few miles.

SOCIAL AND ECONOMIC CONDITIONS

Oil and Gas Industry

The drilling of a Morrow gas well to casing point would require the expenditure of approximately $520,000. If sufficient reserves were proven to justify completing the well as a producer an additional $270,000 would be spent, for a total of $790,000. Of this total, approximately $330,000 would be spent on supplies, $125,000 would be spent directly on salaries, and $335,000 would be spent on services, which are a combination of rental of equipment and the salaries of the workers running the equipment. The above expenditures would be made over a period of about eight weeks.

If the initial well were successful, up to seven additional wells could be drilled and the above expenditures would be repeated seven times, for a total expenditure of about $6.4 million. Of this total, approximately $2.6 million would be spent on supplies, $1 million would be spent on salaries and $2.8 million on services.

Based on the production from nearby wells, it is estimated that between 10 and 50 bcf of gas could be produced from the EIS study area, with a most likely production of about 25 bcf. These reserves would be produced over a period of about 25 years. Between 1986 and 1991, the wellhead price of natural gas in New Mexico has varied between $1.50 and $1.90 per mcf, and is expected to remain in this range for the foreseeable future. Between 1988 and 1991, the federal government has collected between 17 and 20 cents per thousand cubic feet of gas produced from federal leases. Using these guidelines, the value of the produced gas would be between $13 million and $64 million, with a most likely value of $32 million. The value of the federal royalty would be between $1.5 million and $7.5 million, with a most likely value of about $4 million.

In the short-term, expenditures for salaries, supplies, equipment, and the services of subcontractors purchased in Eddy County would enter the local economy. Gross receipts taxes collected on those expenditures would provide support for public services in the area. State government would benefit from collection of excise and ad valorem taxes. The federal and state governments, together, would benefit from the royalty revenue from the wells. Indirectly, the Carlsbad area could benefit over the long-term from the return of some of the royalties collected on the gas produced from the wells.

Tourism (Carlsbad Caverns National Park)

If a well were drilled and completed for production, gas would be produced until exhaustion, and if the well were properly plugged, the impacts to tourism would be negligible. Since the backcountry of CCNP has had less than 500 users per year in recent years, probably fewer than 20 people would be exposed to the sights and sounds of an active drilling rig. During the production period a few people per year may notice the activity associated with maintenance and servicing of the well. During abandonment perhaps another 20 would notice the activity. If full field development were to occur, these effects could be repeated up to seven times more over a period of several years.

Therefore, cumulative impacts to the tourism industry due to oil and gas development would be minor.

WILDERNESS

Selection of Alternatives A, C, D, or E would impact both the BLM Mudgetts WSA and the NPS wilderness area. The access road to the applicant's proposed location makes up about one mile of the western WSA boundary. The pipeline and a portion of the proposed drill pad would be visible from the ridge-top overlook in Section 21. If the RFD wells were drilled, the impacts to the WSA would be greatly increased. Well location 5 in section 23 (see Map A-1) would not be authorized at its present location until the WSA was dropped from wilderness consideration. Well location 5 is on a post-FLPMA lease that is subject to the "nonimpairment criteria" in BLM Handbook H-8550-1.

Although the BLM WSA and the NPS wilderness areas would not be directly impacted, the wilderness experience for visitors using both areas would undergo impacts, especially during the early phases of development. The proximity of the wilderness to the well locations would cause the sights, sounds, and smells of the drilling operation and other construction activities to be readily experienced by people using the northern part of the NPS wilderness area. The sight of drilling rigs, heavy truck traffic, upgraded roads, pipelines, well pads, and production facilities; the smell of fugitive natural gas and H_2S, diesel fumes, and dust; and the sound of drilling rigs, production facilities, and heavy truck traffic would impact and devalue the wilderness experience by eliminating the potential for enjoying solitude in an untrammeled, primitive and unconfined, natural setting.

CULTURAL RESOURCES

A Class III cultural resource inventory was performed on the proposed Diamondback Federal #1 well location and access road route (see Chapter 2, Alternative A) in February 1991 by Archaeological Survey Consultants (BLM Cultural Report #91-NM-067-372). No archeological remains were located and cultural resource clearance was recommended for this location.

Direct impacts to known cultural properties in the EIS study area by implementation of the applicant's proposed action or alternatives are not anticipated. Cultural properties which may exist in the alternate locations proposed for the Diamondback Federal #1 would be identified during inventory prior to permit approval. Any archeological or historical properties discovered would be assessed for significance, with proper treatment a condition for approval of the APD. Similarly, any future actions within the EIS study area where federal surface and/or minerals are involved would require inventory, assessment, and mitigation if necessary as a condition of approval. Because archeological sites have been informally identified along the existing, previously inventoried road leading into Dark Canyon, any improvement proposed for that existing road would be preceded by remedial inventory, with site identification and assessment, and mitigation if necessary prior to approval of the undertaking.

Cumulative and indirect effects to cultural properties in the EIS study area by the proposed action or alternatives, or by future oil and gas development are less easily identified and mitigated. While cultural properties are not located on the proposed Diamondback Federal #1 location (see Chapter 2, Alternative A), the numerous sites informally known in the EIS study area, along with others not yet identified, would be affected by the increased numbers of people utilizing the area. For example, a prehistoric site containing a burned rock midden is known to be present immediately adjacent to the presently proposed access road in the NESE 1/4 of Section 19. This archeological site would be within easy visual and walking distance of the access road and the Diamondback well location, and it would lie within or very near the area which would be impacted by the proposed Alternative C relocation. At least two other extensive prehistoric sites with burned rock midden features exist partially within the area, and are easily visible from the existing road on the floor of Dark Canyon.

Public access to much of the Dark Canyon portion of the study area has, at least in recent years, been effectively blocked by locked gates on intervening private lands. Increased drilling would introduce construction workers, drillers, and operators to the area, who otherwise would not have ready access. Should wells produce, maintenance personnel would be in the area on a regular basis. Pressure may mount on the rancher to open access across the private land, allowing hunters, artifact collectors, and other members of the public who are not associated with the proposed development into the area. Based on general observations elsewhere in the Carlsbad Resource Area, increased development and use of the EIS study area would result in increased awareness of the archeology, and in intensified surface collection or other activities destructive to the integrity and research potential of local cultural resources.

Present New Mexico BLM policy requires cultural resource inventory only for areas which may be directly impacted by proposed undertakings. Inventory of larger blocks which include the locations of proposed developments would be necessary to correctly identify and assess potential indirect and cumulative impacts on cultural resources.

SOILS

Soil disturbance from new construction of the well pad, road, pipeline, and from upgrading roads, would total about 90 acres. The already limited fertility of topsoils would be reduced because of the mixing of soil layers during construction. In the case of abandonment of the well pad and access road, standard industry practice dictates that the caliche surfacing would be mixed with naturally occurring soil, further reducing soil fertility and increasing the difficulty of reclamation.

Soil erosion by wind and water is likely to increase because of the disturbance of previously intact soils. Sedimentation in the Dark Canyon watershed could be increased during major flood events as a result of soil disturbance caused by construction. However, the normal lack of surface water in the area would likely preclude most increases in sedimentation. The loamy soils, if unstabilized, would be susceptible to wind erosion. The regular use of motorized vehicles, especially if wells were commercial, would increase the potential for erosion.

The moderate corrosivity of the soils would likely dictate the need for special prevention measures to reduce the likelihood of pipeline deterioration. Soil fertility would be reduced by material leaking from the pipeline.

Vegetation would also be lost from the occurrence of spills or leaks. Accidents causing spills and leaks of toxic or otherwise environmentally damaging substances can be expected, despite precautions taken to prevent them. Liquid spills (fuel, oil, brine, chemicals) could occur along pipelines, from mud pit failure, at storage tanks and well heads. Hauling of the produced oil off lease via truck would greatly reduce the amount of vegetation lost from pipeline construction, and would eliminate the potential of pipeline leaks. However, continuous trucking of petroleum products out of the area would increase the overall level of disturbance, and would increase the potential for vehicular collisions with attendant possibility of liquid spillage.

VEGETATION

Vegetation would be eliminated from about 50 acres under this alternative, reducing the availability of cover types for wildlife. Vegetation could also be damaged or destroyed in the event of spills or leaks of hydrocarbons or other contaminants near well sites.

WILDLIFE

Wildlife habitat destruction and loss would be minimal. The proposed surface disturbance from construction of pads, roads, and pipelines would cause vegetation loss and habitat destruction amounting to about 50 acres.

The loss of vegetation would directly reduce the availability of cover types required by wildlife: escape, hiding, feeding, nesting and thermal. In essence, the effect of vegetation loss on wildlife would be felt both in the loss of critical forage, and substantially, in the reduction of cover. Physical disturbance to the habitat would also cause the mortality of some small mammals and reptiles that are unable to avoid the construction.

The overall development and subsequent field operation, depending on the life of the well, would also produce a variety of environmental disruptions (i.e. well pad construction, road construction and maintenance, well maintenance, pipeline construction, traffic, etc.), which would impact those wildlife species occupying the study EIS area. These impacts (short and long term) could obstruct travel routes and overall movement of large mammals such as mule deer, disturb or cause abandonment of avian nests, and, residually, displace wildlife to other areas. Wildlife displaced as a result of human disturbance cannot be expected to find suitable, unoccupied habitat to support them in adjacent areas, but would potentially die of natural causes or displace other animals (Klein, 1972). Undisturbed animals will normally exhibit patterns of activity and habitat selection that result in optimization of energy expenditure. Energy expenditure is related to the level of daily activity in addition to maintenance of body temperature (Morganini and Hudson 1979; Geist 1978).

Deviations from the normal activity patterns and habitat use would have an adverse effect on the amount of their available energy and, therefore, the welfare and productivity of an animal and/or a population could suffer. If an animal is unable to compensate for such increases in energy utilization, reproduction, growth, and survival could be greatly reduced (Geist 1970; Owens 1977).

With an increased road density or improved existing access, a greater demand on wildlife and its habitat for recreational purposes would occur. The effects from these secondary activities would be greater over the long term than those from the development phase itself. Inclusion of Appendix D for conditions of approval for special status species would allow mitigation of the potential impacts to wildlife described above.

SPECIAL STATUS SPECIES

There are federal and state listed species within the Dark Canyon EIS study area, as well as potential habitat for a variety of other special status species (both plant and animal). All the known special status animal species are migrants and should not be affected by the proposed action. The special status plant species identified in the area could be expected to be found in and around the applicant's proposed well location and along the alignments of the road and pipeline. Construction activities would destroy individual members of these species, should they be present.

All future lease parcels within the EIS study area would have a "Lease Notice" (R47) attached, (see Appendix D). APDs would also have this notice as a "condition of approval" requiring special status species surveys to be conducted on all surface disturbing activities along the entire Guadalupe escarpment, including the EIS study area. Inclusion of Appendix D for conditions of approval for special status species would allow mitigation of potential impacts.

ALTERNATIVE B
NO ACTION--DENY THE APD AND FUTURE DRILLING WITHIN THE EIS STUDY AREA

OIL AND GAS RESOURCES

The gas reserves from the RFD wells (about 25 bcf, amounting to about $32 million) would not be produced and would remain as a reserve. Because no further oil and gas development would be allowed within the EIS study area, the lessees and operators of leases within the EIS study area would be unable to recover money spent to obtain, maintain, and plan for the development of their leases.

Residual impacts include unrecovered investments made to date by the lessees and operators. No natural gas contained within the EIS study area would be produced from new wells. Existing leases not held by production would expire or terminate without further exploration.

CAVE RESOURCES

Under this alternative there would be no adverse impacts to the cave resources from new development. Cave resources would receive a higher level of protection. Any impacts from previous oil and gas development within the EIS study area is unknown. Cave resources would be preserved in their current state.

WATER RESOURCES

There would be no adverse impacts to water resources from oil and gas development. Water supplies would receive a higher degree of protection. However this does not preclude the possibility of gas being released to the unsaturated zone or surface accidents producing mobile contaminants from existing producing wells in the EIS study area.

VISUAL RESOURCES

No impacts to visual resources would occur under this alternative.

SOCIAL AND ECONOMIC CONDITIONS

If the applicant's APD and any future drilling within the EIS study area were denied, the employment and revenue described under the proposed action would not occur. In addition, this action could discourage future oil and gas leasing, exploration and development in the area. There would be no impact to the tourism industry under this alternative.

WILDERNESS

Under Alternative B, there would be no impacts to wilderness.

CULTURAL RESOURCES

Under Alternative B, there would be no impacts to cultural resources.

SOILS

Under Alternative B, no impacts to soils would occur.

VEGETATION

Under Alternative B, no impacts to vegetation would occur.

WILDLIFE

The result of implementing Alternative B would be maintenance of the status quo with regards to wildlife.

SPECIAL STATUS SPECIES

The result of implementing Alternative B would be maintenance of the status quo with regards to surface values and resources present.

ALTERNATIVE C
RELOCATE DIAMONDBACK WELL PAD AND USE ENHANCED PRECAUTIONARY OPERATIONS WITHIN THE EIS STUDY AREA

OIL AND GAS RESOURCES

The impacts of full-field development of the EIS study area would be similar to Alternative A.

The drilling and subsequent production of the wells under this alternative would result in the production of hydrocarbon reserves in the near future as opposed to the reserves remaining as a resource. The enhanced precautionary operations would increase costs to the operators. Residual and cumulative impacts for this alternative would be similar to Alternative A.

CAVE RESOURCES

Relocation of the Diamondback Federal #1 well pad 500 feet to the east and drilling a total of 8 RFD wells using enhanced precautionary operations would reduce the cumulative impacts described in Alternative A. This reduction is accomplished through avoidance of known lineaments and anomalies and mitigation of the impacts on caves if one were present. Moving the well to the east of the applicant's proposed location is designed to avoid a natural potential anomaly identified in the area and, subsequently, reducing the potential for encountering caves, voids and fractures. A site-specific lineament survey for each APD would further enhance cave avoidance efforts.

Requiring a completely enclosed mud system, i.e., steel tanks, and having all the cuttings hauled to an authorized disposal site would reduce the potential impacts of drilling muds and chemicals leaching from the surface into a cave system.

The use of air drilling through the potential cave formations would reduce impacts from liquid mud systems entering a zone of lost circulation. The cumulative impacts associated with cementing and casing are also reduced under this alternative. This is achieved through the use of higher quality casing and cement and the requirement for 100% bonding of the cement. Other mitigation would include 24 hour/day compliance monitoring by a BLM or contracted representative during drilling and completion operations with periodic compliance monitoring during the productive life of the well.

Standards developed by the National Association of Corrosion Engineers (NACE Standard MR-01-75) are exceeded in the determination of the quality of the steel casing used in the RFD wells, so as to further reduce the action of corrosive agents on the casing and to reduce the likelihood of casing deterioration.

Special cementing procedures and cement standards, (described in Appendix B) would be required for Alternatives C, D, and E to reduce the amount of lost cement in downhole voids, thereby reducing impacts. Even with the above mitigation, if a void were encountered, an undetermined amount of cement mixture may still enter during the cementing process. This volume varies significantly depending on depth and borehole size. However, the volume of cement would be reduced from Alternative A through the requirement to use special cements, such as thixotropic or time-dependent cements or special additives.

The proposed mitigation for Alternatives C, D, and E would depend on the situation and the void size. If a void were encountered, a determination would be made by the BLM drilling specialist on-site in consort with the Carlsbad Resource Area Manager and specialists, as to whether a cave had been intercepted. If determined that a cave were not intercepted, decisions would then be made regarding cementing. The prospects available for cementing voids include: a staged cement job, as recommended by the Cave and Karst Area Task Force (1991), the use of various nontoxic lost circulation materials, such as cottonseed hulls and cellophane flakes, additives for the cement, and the use of pressure controlled (thixotropic) and time controlled (gypsum/resin, i.e., cal-seal or hydromite) setting cements.

For extreme lost circulation cases, "1-inching" could be used for remedial action. For this, a temperature survey would be run to determine the top of the cement, to determine where the primary cement job failed to provide complete coverage behind the intermediate casing. A 1-inch pipe would be run down the annulus outside the intermediate casing in an effort to tag the top of the cement. The remedial cementing would entail pumping cement containing nontoxic lost circulation material and accelerators through this pipe in consecutive stages until the void is sealed and the annular space is cemented to surface. However, if pea gravel were used as an additive, the integrity of the cement sheath may be impaired; use of pea gravel is not recommended.

Because it is impossible to know for sure that the void is not actually a cave passage, cumulative impacts due to filling a cave with cement may occur, as described in Alternative A.

Although using a staged cement job would reduce the penetration of cement into a void, the staged cement method may actually cause impacts to cave values because the void may connect with a cave, and this portion would not be sealed off with cement. (The impacts from leaking casing due to ineffective cement jobs are described under Alternative A.)

Summary

The cumulative impacts for developing a natural gas field based on the RFD of 8 well locations may be diminished for Alternative C, because of cave avoidance and surface/subsurface mitigation. However, as discussed earlier, lineament surveys, natural potential surveys, and the helium study indicate high potential for major cavern development and inadvertent impacts on cave resources may occur. The increase of traffic resulting from oil and gas exploration and production could also result in more cave use and greater potential for vandalism in the caves.

Cement that would enter voids or cave passages would not be recovered. In the case of small voids, the voids would be plugged with cement. In the case of a cave, a passage or room could be partially or completely plugged with cement. Long-term impacts of leaky casings due to corroded pipe, poor cementing, or staged cementing could allow hydrocarbons to leak into the cave systems and cause permanent damage to the environment and cave resources, possibly causing human deaths from explosions or asphyxiation. However, these impacts may be diminished under this alternative because of the implementation of the downhole mitigative measures and the BLM monitoring that would occur during drilling, completion, and production.

WATER RESOURCES

All impacts to water resources would be similar to Alternative A. The relocation of well #1 to avoid known lineaments and the BLM site-specific lineament survey would reduce the likelihood of encountering large subterranean openings, although not all lineaments appear to overlie caves, and not all caves are located beneath mappable lineaments. Enhanced precautionary operations should reduce (but not eliminate) the possibility of contamination. Extra caution in reciprocating the casing during cementing may be particularly important in ensuring that gas is not released during the production period. Also, the use of steel pits at individual well sites would minimize the leaching of drilling mud and wastes from the surface, effectively eliminating that potential pollution source.

VISUAL RESOURCES

Impacts to visual resources would be the same as for Alternative A.

SOCIAL AND ECONOMIC CONDITIONS

The enhanced precautionary operations (see Appendix B) would result in an increased cost of approximately $76,500 per well drilled, or a total increased expenditure of $612,000 for all eight RFD wells. The volume of gas produced, the value of that production, and the royalty revenue generated would be similar to that described in alternative A. The impacts to tourism would also be similar to those described in alternative A.

WILDERNESS

Impacts under this alternative would be similar to Alternative A.

CULTURAL RESOURCES

Alternative C proposes relocation of the Diamondback Federal #1 well to a point 500 feet to the east. An archeological site marked by a burned rock midden feature is known in this general vicinity. A Class III inventory of the proposed new location and for the other RFD wells would be required before potential impacts to this, or other cultural resources can be fully assessed. Otherwise, impacts to cultural resources would be similar to Alternative A.

SOILS

Impacts to soils under this alternative would be similar to Alternative A.

VEGETATION

Impacts to vegetation under this alternative would be the same as for Alternative A, except that only about 45 acres would be disturbed.

WILDLIFE

Wildlife habitat destruction and loss would be minimal, as described in Alternative A. The proposed surface disturbance from construction of pads, roads, and pipelines would cause vegetation loss and habitat destruction amounting to about 45 acres.

SPECIAL STATUS SPECIES

Impacts under this alternative would be similar to Alternative A.

All future lease parcels within the EIS study area would have a "Lease Notice" (R47) attached, (see Appendix D). APDs will also have this notice as a "condition of approval" requiring special status species surveys for all surface-disturbing activities along the entire Guadalupe escarpment, including the EIS study area. Inclusion of Appendix D for conditions of approval for special status species would allow mitigation of potential impacts.

ALTERNATIVE D
DIRECTIONALLY DRILL FROM AN EXISTING WELL PAD AND USE ENHANCED PRECAUTIONARY OPERATIONS WITHIN THE EIS STUDY AREA

OIL AND GAS RESOURCES

The drilling and subsequent production of the wells under this alternative would result in the production of hydrocarbon reserves in the near future as opposed to the reserves remaining as a resource. Additional geologic information would be gained about drilling in a cave/karst environment over that of Alternative A, as a BLM representative would be on-site during drilling, allowing refinement of resource occurrence maps and also more precision in the resultant order and siting of remaining development wells in the play.

Additionally, the potential zones of lost circulation in the immediate area would be better understood through the use of a downhole video camera. The enhanced precautionary operations would increase costs to the operators (see the Social and Economic section of this alternative).

Directional drilling of the Diamondback well could result in drilling and cementing problems and increased costs. Drilling the Diamondback well from the existing #1 Sidewinder pad would reduce the chance for encountering unknown lost circulation zones in the shallow formations.

Residual and cumulative impacts would be the same as for Alternative A.

CAVE RESOURCES

The cumulative impacts for the EIS study area would be similar to Alternative C. However, moving the well to the existing Sidewinder well pad brings the Diamondback location closer to a known lineament. The data derived from the drilling of the Sidewinder well would seem to support this location as one that reduces the possibility of encountering a cave.

WATER RESOURCES

Impacts to water resources would be similar to those for Alternative C.

VISUAL RESOURCES

Visual resource impacts would be similar to those for Alternative A.

SOCIAL AND ECONOMIC CONDITIONS

The cost to drill a directional well is about $62,000 more than a vertical well. When combined with the cost of the enhanced precautionary operations (see Appendix B), this would increase the cost of the Diamondback well by $138,500. The effect of this alternative is to increase the cost of drilling all eight wells by about $674,000 above the expenditures given in Alternative A. The volume of gas produced, the value of that production, and the royalty revenue generated would be similar to that described in Alternative A. The impacts to tourism would also be similar to those described in Alternative A.

WILDERNESS

Impacts to wilderness would be similar to Alternative A.

CULTURAL RESOURCES

Alternative D proposes drilling from the existing Sidewinder #1 well location in Section 20. No cultural clearance has been performed for this location as it is private surface and private minerals; potential effects to cultural resources in the vicinity are unknown. A Class III inventory of the Sidewinder location and for the other RFD wells would be required before potential impacts to this, or other cultural resources can be fully assessed.

Otherwise, impacts to cultural resources would be similar to Alternative A.

SOILS

Impacts to soils under this alternative would be similar to Alternative A, except 90 acres would be disturbed due to the extra pipelines required.

VEGETATION

Under this alternative, impacts would be similar to Alternative A, except for about 45 acres being disturbed.

WILDLIFE

Wildlife habitat destruction and loss would be minimal, as described in Alternative A. The proposed surface disturbance from construction of pads, roads, and pipelines would cause vegetation loss and habitat destruction amounting to about 45 acres.

SPECIAL STATUS SPECIES

Impacts under this alternative would be similar to Alternative A, except that about 56 acres would be affected.

All future lease parcels within the EIS study area would have a "Lease Notice" (R47) attached, (se Appendix D). APDs would also have this notice as a "condition of approval" requiring T&E species surveys to be conducted on all surface-disturbing activities along the entire Guadalupe escarpment, including the Dark Canyon EIS study area. Inclusion of Appendix D for conditions of approval for special status species would allow mitigation of potential impacts.

ALTERNATIVE E
DIRECTIONALLY AND VERTICALLY DRILL TO MULTIPLE TARGETS USING ENHANCED PRECAUTIONARY OPERATIONS WITHIN THE EIS STUDY AREA

OIL AND GAS RESOURCES

Residual and cumulative impacts would be similar to Alternative A; however, with the problems associated with directional drilling (discussed under Alternative D) there would be increased liability to operators because of the sharing of the borehole on the drilling island.

CAVE RESOURCES

The proposed location for the drilling island in the SW1/4 of Section 19 avoids known lineaments and moves the location of drilling the Diamondback and two or three other wells further from cave resources. For the 8-well RFD, only four pads would be required, reducing the possibility of encountering voids or cave resources because of the reduction of individual drill pads.

WATER RESOURCES

A single well pad serving several leases would reduce the amount of surface disturbance, and the associated risk of groundwater contamination from that source in Dark Canyon.

However, moving the surface location of the Diamondback well to a new location with unknown risks increases the chances of void encounters, unlike Alternative D where drilling risks are already known for the Sidewinder well location. Otherwise, all impacts associated with Alternative E are similar to those discussed in Alternative C.

VISUAL RESOURCES

Impacts would be similar to Alternative A. However, Alternative E would have a greater concentration of disturbance at one location because of the drilling island concept. Having multiple targets that would be drilled from that location would require additional facilities, increasing visual intrusions at that location.

SOCIAL AND ECONOMIC CONDITIONS

The cost to drill a directional well would be about $62,000 more than a vertical well. When combined with the cost of the enhanced precautionary operations (see Appendix B), this will increase the cost of the Diamondback and Well #4 by $138,500 each. The effect of this alternative is to increase the cost of drilling all eight RFD wells by $812,000 above the expenditures given in Alternative A. The volume of gas produced, the value of that production, and the royalty revenue generated would be similar to that described in Alternative A. The impacts to tourism would also be similar to those described in Alternative A.

WILDERNESS

Impacts to wilderness would be similar to Alternative A.

CULTURAL RESOURCES

Impacts to cultural resources would be similar to Alternative A.

Alternative E proposes a drilling island in the SW 1/4 of Section 19. A rockshelter containing prehistoric cultural remains has been identified on the canyon wall immediately north of this location. A Class III cultural resource inventory would be required for the proposed drilling island location before potential impacts to this or other cultural resources can be fully assessed.

SOILS

Impacts would be similar to Alternative A, except that there would be a slight reduction in the degree of impact from 2 less drill pads and less pipeline and road construction. Approximately 56 acres would be disturbed.

VEGETATION

Impacts to vegetation under this alternative would be similar to Alternative A, except only about 28 acres would be disturbed.

WILDLIFE

Wildlife habitat destruction and loss would be minimal, as described in Alternative A. The proposed surface disturbance from construction of pads, roads, and pipelines under this alternative would cause vegetation loss and habitat destruction amounting to about 28 acres.

SPECIAL STATUS SPECIES

Impacts under this alternative would be similar to Alternative A, except that only about 56 acres would be affected.
All future lease parcels within the EIS study area would have a "Lease Notice" (R47) attached (see Appendix D-1). APDs will also have this notice as a "condition of approval" requiring special status species surveys to be conducted on all surface disturbing activities along the entire Guadalupe escarpment, including the Dark Canyon EIS study area. Inclusion of Appendix D for

conditions of approval for special status species would allow mitigation of potential impacts.

CHAPTER 5
CONSULTATION AND COORDINATION

CHAPTER 5: CONSULTATION AND COORDINATION

THE SCOPING PROCESS

The Council on Environmental Quality Regulations implementing the National Environmental Policy Act (40 CFR, Part 1501.7) requires an early and open scoping process as part of the preparation of an EIS. During this process for this Dark Canyon EIS, the scope and importance of issues related to the applicant's proposed action were identified. Information obtained through scoping was one of the sources used to determine which impact topics would be addressed in this EIS in detail. Additionally, scoping was used to inform affected federal, state and local agencies and interested parties about the applicant's proposed action and to identify existing environmental reports and technical information relevant to the assessment of impacts.

The Notice of Intent (NOI) to prepare this EIS was published in the *Federal Register* on October 10, 1991. The NOI announced the public scoping meeting held in Carlsbad, New Mexico, on October 29, 1991. Following publication of the NOI, a "scoping package" of information on the proposed action and BLM's preparation of an EIS as well as a questionnaire was mailed out during October 1991, to over 200 agencies and interested publics.

The initial scoping period for the Dark Canyon EIS closed on November 12, 1991, by which time BLM had received more than 200 oral and written comments on the proposal from about 100 organizations and individuals. This initial scoping effort developed five significant issues related to oil and gas development: cave resources; water resources; social and economic factors; visual resource issues; and special status species. These issues are displayed on Figure 5-1. Mitigation measures for oil and gas development identified during scoping are shown on Figure 5-2.

ADDITIONAL PUBLIC AND AGENCY INVOLVEMENT

During December 1991, the Regional Director, National Park Service Southwest Region, agreed that NPS should be a formal cooperating agency for this EIS. NPS has also provided staff expertise from Carlsbad Caverns National Park (CCNP) to assist BLM with preparation of the Affected Environment and Environmental Consequences sections of this EIS related to cave and other resources within CCNP.

The U.S. Geological Survey (USGS) has also provided a hydrologist for the writing the Water Resources portion of this EIS.

Figure 5-1
ISSUES IDENTIFIED DURING SCOPING
(Dark Canyon EIS Team, 1992)

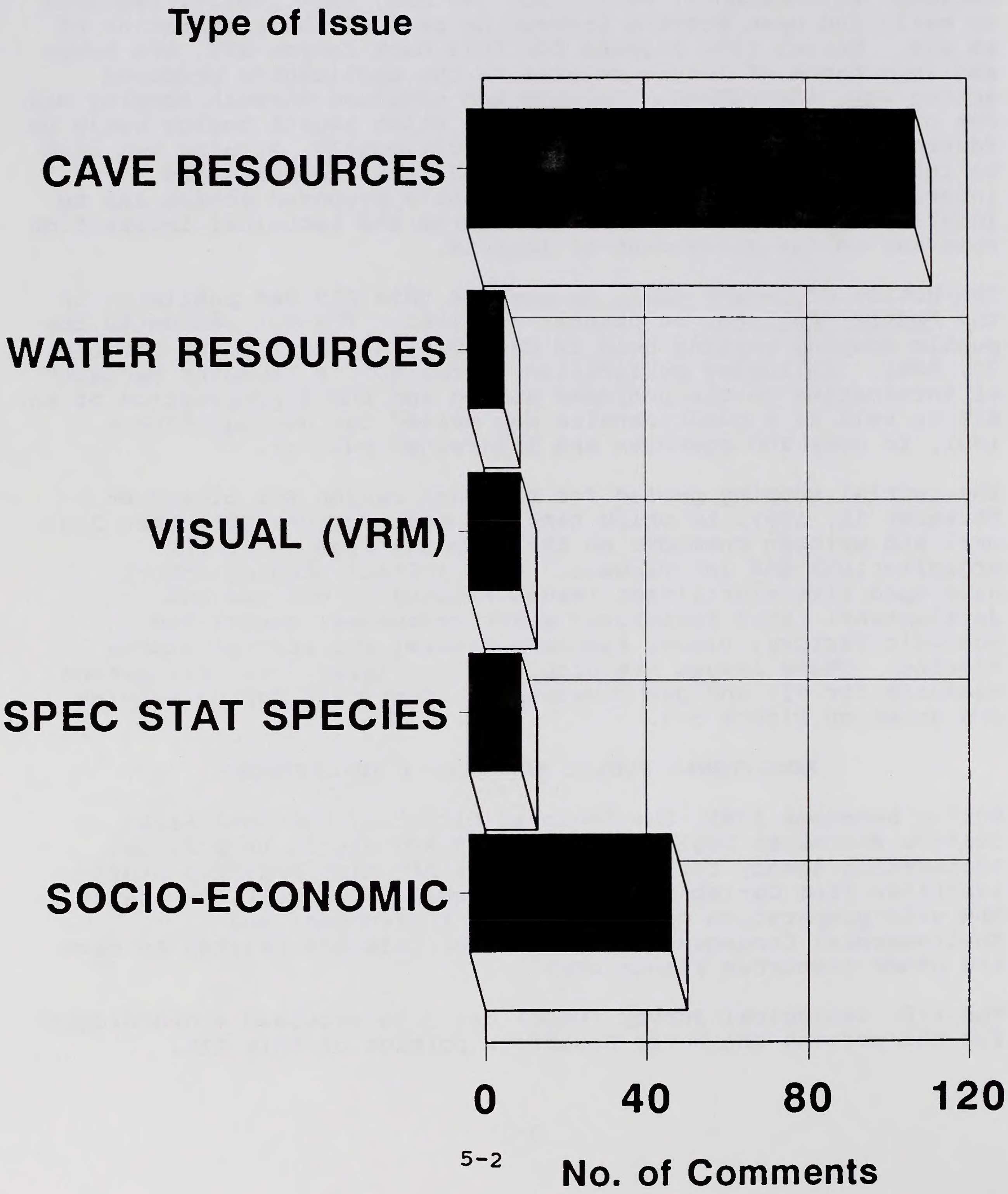
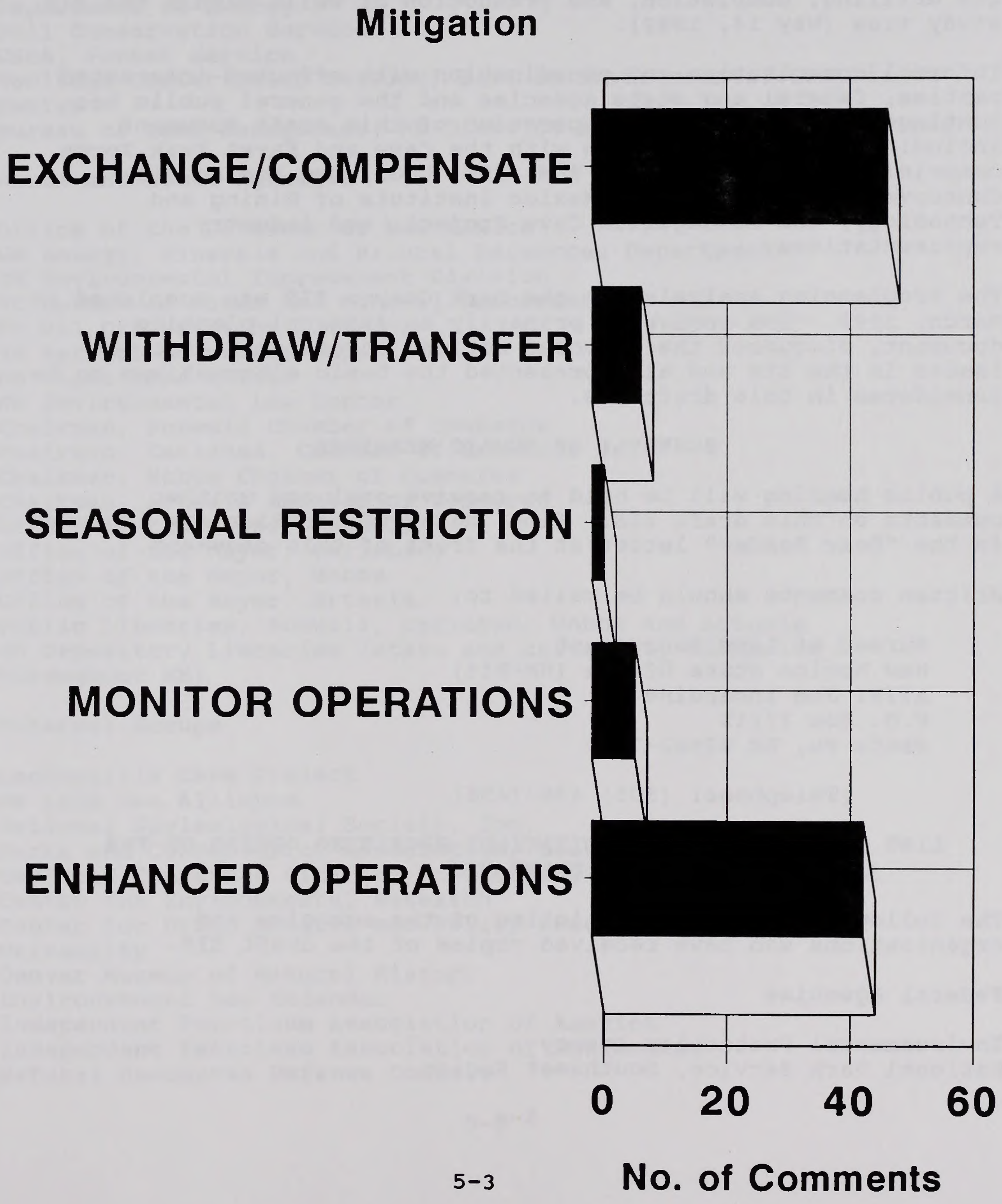


Figure 5-2
MITIGATION IDENTIFIED DURING SCOPING
(Dark Canyon EIS Team, 1992)



Since the initial scoping letter and questionnaire for this EIS, BLM has sent out two additional letters to further solicit comments and provide updates to all interested parties. Updates were provided on: 1) scoping issues and alternatives formulated, information on the multidisciplinary team; and 2) tentative EIS schedule (February 26, 1992); BLM also requested any comments on potential mitigative methods which would be applied to oil and gas drilling, completion, and production of wells within the EIS study area (May 14, 1992).

Informal consultation and coordination with affected interested parties, federal and state agencies and the general public has continued throughout the preparation of this draft document, including close coordination with the Cave and Karst Task Force, comprising individuals from BLM, NPS, USGS, New Mexico Oil Conservation Division, New Mexico Institute of Mining and Technology, the Lechuguilla Cave Project, and industry representatives.

The Preplanning Analysis for the Dark Canyon EIS was completed in March, 1992. The analysis, primarily an internal planning document, discussed the proposed action, anticipated resource issues in the EIS and also presented the basic alternatives to be considered in this draft EIS.

SCHEDULE OF PUBLIC HEARINGS

A public hearing will be held to receive oral and written comments on this draft EIS. Time, date and location are included in the "Dear Reader" letter at the front of this document.

Written comments should be mailed to:

Bureau of Land Management
New Mexico State Office (NM-911)
ATTN: Joe Incardine
P.O. Box 27115
Santa Fe, NM 87502-7115

(Telephone: (505) 438-7458)

LIST OF AGENCIES & ORGANIZATIONS RECEIVING COPIES OF THE DRAFT EIS

The following is a partial listing of the agencies and organizations who have received copies of the draft EIS.

Federal Agencies

Environmental Protection Agency
National Park Service, Southwest Region

U.S. Geological Survey, Water Resource Division, Central Region
NPS, Division of Environmental Compliance
Bureau of Mines
Department of the Interior, Office of Environmental Project Review
Bureau of Reclamation
Fish and Wildlife Service
Minerals Management Service
Department of Energy
Soil Conservation Service
USDA, Forest Service
Heritage Conservation Service, Div. of Environmental Compliance Review
Bureau of Land Management, NM District and Resource Area Offices

State and Local Agencies

Office of the Governor of New Mexico
NM Energy, Minerals and Natural Resources Department
NM Environmental Improvement Division
NM Bureau of Mines and Mineral Resources
NM Oil Conservation Division
NM Natural Resources Department
NM State Land Office
NM Environmental Law Center
Chairman, Roswell Chamber of Commerce
Chairman, Carlsbad, Chamber of Commerce
Chairman, Hobbs Chamber of Commerce
Chairman, Artesia Chamber of Commerce
Office of the Mayor, Roswell
Office of the Mayor, Carlsbad,
Office of the Mayor, Hobbs
Office of the Mayor, Artesia
Public Libraries, Roswell, Carlsbad, Hobbs and Artesia
NM Depository Libraries (state and university libraries throughout NM)

Interest Groups

Lechuguilla Cave Project
NM Land Use Alliance
National Speleological Society, Inc.
Parks and Conservation Association, Southwest Region
Carlsbad Concerned Citizens for Responsible Land Management
Center for Environmental Research
Center for Urban Affairs and Policy Research, Northwestern University
Denver Museum of Natural History
Environmental Law Calendar
Independent Petroleum Association of America
Independent Petroleum Association of New Mexico
Natural Resources Defense Council

The Nature Conservancy
New Mexico Landsman's Association
New Mexico Mining Association
New Mexico Oil and Gas Association
Public Lands Action Network
Rocky Mountain Oil and Gas Association
Sierra Club
Society of Petroleum Engineers
Southeastern New Mexico Audobon Society
Southwest Research and Information Center
The Wilderness Society

Industry and Related Groups

Amax Oil and Gas, Inc.
American Trading and Production
AMOCO Production Company
Arapaho Drilling
ARCO Oil and Gas
Chevron USA, Inc.
Collins and Way, Inc.
Desana Corporation
Edcor Electronics
El Paso Exploration
Exama Oil Company
Halliburton
Featherstone Development Corporation
Hamo Operating Co.
McClellan Oil Corporation
Memorial Exploration Company
Mesa Operating
Oxy USA, Inc.
Transwestern Pipeline Company
Weed Oil and Gas
Yates Energy Corporation
Yates Petroleum Corporation

In addition to the above, copies were sent to about 150 individuals of the general public who expressed an interest in the project during scoping and the preparation of this EIS.

TABLE 5-1

LIST OF PREPARERS

Team Member	EIS Responsibility	Education	Years Related Experience
Joe Incardine	Team Leader	B.S., Geology	14
Don Boyer	Ass't. Team Leader, Writer-Editor	M.A., Educ. B.G.S., English	16
Bill Dalness	Leasing/Regulatory Issues	B.S., M.S. Geology	21
Powell King	Social/Econ. Factors	B.S., Mining Engineering	10
Kirk Koch	Water Resources Coordinator	B.S., Natural Resource Mgmt.	13
Jim Pettingill	Oil and Gas Resources, Development Scenarios	B.S., M.S. Geology	20
Shannon Shaw	Petroleum Engineering Mitigative Measures	B.S., Pet. Engineering	6
Jim Goodbar	Caves, Visual Resources, Wilderness	B.S., Parks & Recreation Mgmt.	32
John Sherman	Wildlife Biology, Special Status Species	B.S., Wildlife Management	6
Michael Kyte	Archeology	B.S.,M.S., Anthropology	22
Rudy Romero	Cartographics	High School	26
Dale Pate (NPS)	NPS Cave Resources Wilderness	B.A., Geography	22
John McLean (USGS)	Water Resources	B.S., Hydrology	26
Steve Daly	Soil Resources	B.S., Wildlife	11

Reviewers and Contributors

New Mexico State Office

Bill Overbaugh--Cave Resources, Visual Resources
Mark Blakesly-- Water Resources
Barb Masinton--Wildlife & Vegetation, Special Status Species
J.W. Whitney--NEPA Compliance
Rick Wymer--Oil and Gas Resources, Foreseeable Development
Steve Salzman--Enhanced Precautionary Operations
Leo Hosenfeld--Social and Economic Factors
Dave Mensing--Wilderness
Louann Jacobson-Ball--Cultural Resources

National Park Service

Joe Sovick--NPS Cave Resources
Ron Kirbo--NPS Cave Resources

APPENDICES

APPENDIX A: *REASONABLE FORSEEABLE DEVELOPMENT SCENARIOS*

APPENDIX B: *ENHANCED PRECAUTIONARY OPERATIONS*

APPENDIX C: *STIPULATIONS FOR LEASES WITHIN THE EIS STUDY AREA*

APPENDIX D: *WILDLIFE AND SPECIAL STATUS SPECIES*
1. Lease Notice (R47) for Special Status Species
2. Wildlife and Plant Species List

APPENDIX E: *VISUAL RESOURCES*
1. Conditions of Approval
2. Visual Resource Management Ratings

APPENDIX F: *WATER RESOURCES*

APPENDIX G: *DIAMONDBACK FEDERAL NO. 1 WELL APPLICATIONS AND AGREEMENTS*
1. Application for Permit to Drill (APD)
2. Road Right-of-Way Application
3. Surface Owner Agreement

APPENDIX A

REASONABLE FORSEEABLE DEVELOPMENT SCENARIO

APPENDIX A
REASONABLE FORESEEABLE DEVELOPMENT (RFD) SCENARIO

Reasonable foreseeable development (RFD) scenarios for oil and gas resources have been projected for each alternative. The wells for these scenarios would be in addition to existing wells that are either producing, shut in, or plugged and abandoned (see Map 3-3). The RFD's have been compiled so that cumulative impacts on the environment can be assessed. These are not "worst case scenarios" but a compilation of likely targets based upon an examination of isolith (net pay) maps, avoidance of lineaments, and where topography permits a drill pad to be located. Chapter 3, Oil and Gas Resources, discusses at length the geology and the target formations which are likely to produce hydrocarbons within the EIS study area.

A summary of the RFD's is listed below:

1) The principal hydrocarbon target formation in the Dark Canyon EIS study area is the Middle Morrow.

2) The Strawn Formation is a secondary target that may be developed in some wells after any Morrow production has been depleted.

3) Development of other formations is unlikely, based upon current information.

4) A maximum of eight undeveloped spacing units within the EIS study area would be likely development targets; the remaining 13 undeveloped spacing units are considered unlikely to be developed.

5) The life of a typical well, assuming that both the Morrow and Strawn are produced, would be between 15 and 30 years. Twenty years is a reasonable average for planning purposes.

RATIONALE FOR RFD TARGETS

A summary of likely targets are summarized below on Table A-1 and A-2 and displayed on Map A-1 at the back of this appendix.

TABLE A-1

REASONABLE FORESEEABLE SURFACE LOCATIONS

(Compiled by Dark Canyon EIS Team, 1992)

(Please Refer to Map A-1; Locations are Subject to Change.)

WELL #	STATUS	APPROXIMATE SURFACE LOCATION		SPACING
		T. 24 S., R. 24 E.:		
1	Proposed well	2007'FSL & 1063'FEL	Sec. 19	E 1/2 spacing
1A	Alternate well	2007'FSL & 563'FEL	Sec. 19	E 1/2 spacing
2	Development	750'FSL & 1700'FWL (drilling island)	Sec. 19	W 1/2 spacing
3	Development	700'FNL & 450'FEL	Sec. 30	E 1/2 spacing
4	Development	500'FNL & 2100'FWL	Sec. 30	W 1/2 spacing
5	Development	1400'FSL & 1400'FEL	Sec. 23	S 1/2 spacing
6	Development	2100'FSL & 1300'FWL	Sec. 24	W 1/2 spacing
7	Development	1800'FSL & 1100'FEL	Sec. 24	E 1/2 spacing
		T. 24 S., R. 23 E.:		
8	Development Directionally drilled to intercept a target in E 1/2 of Sec. 24 (this lease has a no surface occupancy stipulation for part of the lease.)			

(**Source:** Dark Canyon EIS Project Files, 1992.

TABLE A-2

REASONABLE FORESEEABLE DEVELOPMENT TARGETS FOR EACH ALTERNATIVE

Alternative A: Targets: 1, 2, 3, 4, 5, 6, 7, and 8.
Alternative B: No additional development would be permitted within the EIS study area.
Alternative C: Targets: 1A, 2, 3, 4, 5, 6, 7, and 8.
Alternative D: Targets: 1 (directionally from Sidewinder pad), 2, 3, 4, 5, 6, 7, and 8.
Alternative E: Targets: 1 (directionally) 2 (drilling island), 3, 4 (directionally), 5, 6, 7, and 8 directionally).
(**Source:** Dark Canyon EIS Project Files, 1992.)

The rationale for those spacing units that are likely locations and targets for development (displayed in Tables A-1 and A-2) are discussed below. Wells are shown on Map A-1.

T. 24 S., R. 24 E.

Well #1, East half of section 19 - This is the spacing unit containing the applicant's proposed location. The location is 2007'/S & 1063'/E; an alternative location designated in Alternative C of this EIS is 2007'/S & 563'/E. This is the best spacing unit to test the interpreted gas field, both from a structural and net pay standpoint. The spacing unit may also be tested by a directionally-drilled well located either at the site of the #1 Sidewinder well (Alternative D) or in the west half of section 19 (Alternative E).

Well #2, West half of section 19 - This spacing unit would be a logical site for a development well if the Diamondback well were successful. A good surface location would be approximately 750' FSL & 1700 FWL. This location would also be used for a "drilling island" in Alternative E of this EIS. The location is just east of the Rock Tank fault, in a position to encounter a good thickness of gassy sands. The site is located just off the Dark Canyon road.

Well #3, East half of section 30 - This spacing unit would be a logical site for a development well if the Diamondback well were successful. A good surface location would be approximately 700' FNL & 450'FEL. Both structural and stratigraphic positions look promising for the possible accumulation of gas. Access is good, with the proposed site located just off the Dark Canyon road. The spacing unit could also be reached by a directionally drilled well located in the west half of section 19, although this would require a kickout of almost 0.7 miles.

Well #4, West half of section 30 - This spacing unit would be a logical site for a development well if the #1 Diamondback were successful. A good surface location would be approximately 500' FNL & 2100' FWL. Both structural and stratigraphic positions look promising for the possible accumulation of gas. Access is good, with the proposed site located just off the Dark Canyon road. This spacing unit could also be reached by a directionally-drilled well located in the west half of section 19.

Well #5, South half of section 23 - This spacing unit would be a logical site for a development well in the eastern portion of the EIS study area. However, the best surface location for this well lies within the Mudgetts WSA (see Map 3-12), and no drilling is permitted within a WSA until a determination is made by Congress that the area should or should not be designated wilderness. This is a separate play from the development proposed by the applecant for the area surrounding the Diamondback Federal #1 location. The stratigraphic position is promising for the possible accumulation of gas. Access is provided by a jeep trail, which would have to be improved. The proposed site is outside the portion of the section that is affected by seasonal drilling stipulations.

Well #6, West half of section 24 - This spacing unit is a logical site for a development well in the eastern portion of the EIS study area. This is a separate play from the development proposed by the applicant for the area surrounding the Diamondback #1 location. A possible surface location would be approximately 2100' FSL & 1300' FWL. The stratigraphic position is promising for the accumulation of gas. Access is provided by a dirt road that may have to be improved; about 0.2 miles of new road would have to be built, which would cross an ephemeral creek bed.

Well #7, East half of section 24 - This spacing unit is a logical site for a development well in the eastern portion of the EIS study area. This is a separate play from the development proposed for the area surrounding the Diamondback #1 location. A possible surface location would be approximately 2000' FSL & 1100' FEL. The stratigraphic position is promising for the accumulation of gas. Access is provided by a dirt road that may have to be improved; about 0.2 miles of new road would have to be built, which would cross an ephemeral creek bed.

T. 24 S., R. 23 E.:

Well #8, East half of section 24 - Although this spacing unit is located on the west side of the Rock Tank fault, it is a possible development target if the Diamondback #1 well were successful. Data obtained from the Diamondback and subsequent drilling may refine mineral occurrence maps and make drilling this objective worth the risk. Although only the southern portion of the lease has a No Surface Occupancy (NSO) stipulation (see Appendix C), the only readily accessible drill sites are within the NSO area, effectively requiring directional drilling to reach the principal target, which would be in the northeast area of the spacing unit. This target would probably be reached from a site in the west half of section 19, although another drill site could be located from section 13 (outside the EIS study area). An access road could be built from section 13 to the extreme northern portion of the spacing unit, if it were economically and environmentally feasible.

RATIONALE FOR SPACING UNITS UNLIKELY TO BE DEVELOPED

The remaining undrilled spacing units within the EIS study area are unlikely to be developed in the foreseeable future. These spacing units and the reasons that they are unlikely to be developed are discussed below:

T. 24 S., R. 23 E.

West half of section 24 - Mapping the distribution of gas accumulations west of the Rock Tank fault becomes somewhat speculative, but it appears that this spacing unit contains only the thinning edge of the Morrow deposit. The existing and future oil and gas leases are partially stipulated NSO. However, there are no topographic locations for drill sites outside the NSO area, which would effectively require directional drilling. Unless testing of the east half of this section by directional drilling reveals new information indicating that more gas has accumulated than previously thought (requiring revision of resource occurrence maps), then no development is likely.

North half of section 25 - Mapping the distribution of gas accumulations west of the Rock Tank fault becomes somewhat speculative, but it appears that this spacing unit contains only the thinning edge of the Morrow deposit. A well drilled in the south half of the section had a drill stem test with negative results. The well was plugged and abandoned. Existing and future oil and gas leases would be stipulated NSO, which would require directional drilling from section 19. No development is likely.

North half of section 33 - This area is on the upthrown side of the Huapache fault. Both wells drilled on this side of the fault have proven dry. The Morrow isolith maps indicate no gas accumulation. Federal leases are stipulated NSO, although the surface is private. No development is likely.

South half of section 33 - This area is on the upthrown side of the Huapache fault. Both wells drilled on this side of the fault have proven dry. The Morrow isolith maps indicate no gas accumulation. Federal leases are stipulated NSO, although the surface is private. No development is likely.

North half of section 34 - This area is on the upthrown side of the Huapache fault. Both wells drilled on this side of the fault have proven dry. The Morrow isolith maps indicate only minimal gas accumulations, if any. Federal leases are stipulated NSO, although portions of the lease are private surface. No development is likely.

South half of section 34 - This area is on the upthrown side of the Huapache fault. Both wells drilled on this side of the fault have proven dry. The Morrow isolith maps indicate only minimal gas accumulations, if any. Federal leases are stipulated NSO, although portions of the lease are private surface. No development is likely.

North half of section 35 - This area is on the upthrown side of the Huapache fault. Both wells drilled on this side of the fault have proven dry. The Morrow isolith maps indicate only minimal gas accumulations, if any. Leases are stipulated NSO. No development is likely.

T. 24 S., R. 24 E.:

East half of section 15 - The Morrow isolith maps show that any accumulation of gas, if any, is likely to be found in the extreme southeastern portion of this spacing unit. The #5 Lechuguilla Canyon well, located in the SENW of this section, drill stem tested the Bone Spring, Upper Strawn, Morrow, and Barnett Shale Formations without finding any significant show of hydrocarbons. The land is currently unleased. Any drilling location would require building over one-half mile of road over difficult terrain. Development of this spacing unit is possible, but unlikely.

South half of section 17 - The Morrow isolith maps show that any accumulation of gas, if any, is likely to be located in the extreme southwestern portion of the spacing unit. This area is topographically inaccessible. Any well would have to be drilled directionally from a location at least 0.6 miles away. The #1 Sidewinder to the south proved barren in the possibly productive zones, and the #1 Chaparral OZ Federal in the SENE of this section has produced only 0.71 bcf from the Morrow in the twelve years through January 1992. No development is likely.

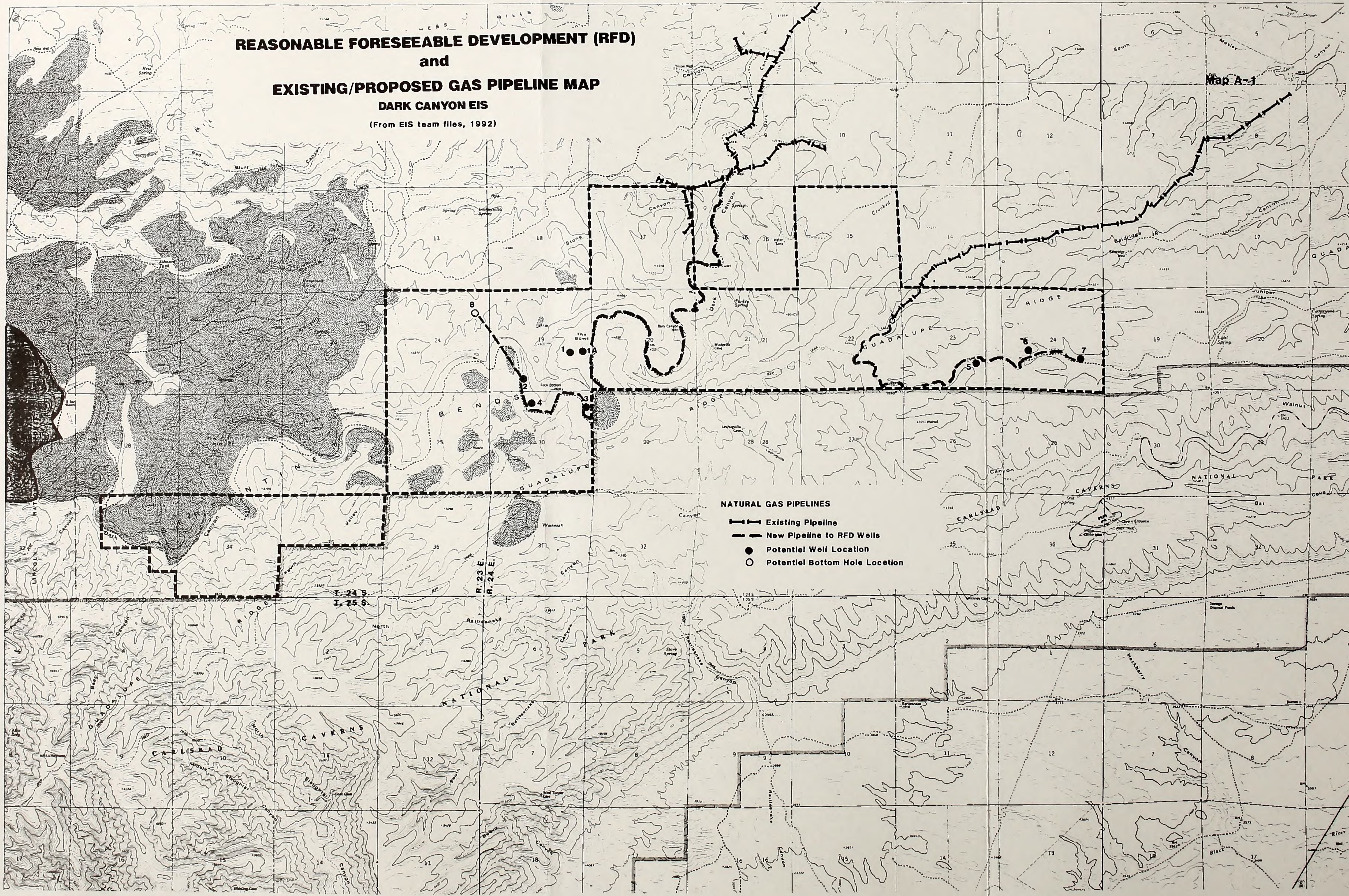
East half of section 20 - This area appears to be on the thinning edge of the Morrow gas accumulation. The #1 Sidewinder well, located in this section just west of this area, tested the possibly productive intervals with negative results, despite better structural position and a thicker potential pay zone. Federal leases within the spacing unit are stipulated NSO. No development is likely.

North half of section 21 - The Morrow isolith maps show that this area has a very thin accumulation of gas sands. The Federal subsurface is unleased, and is designated to be stipulated NSO on any future leases; any drilling would have to be on the N2NW, which is private surface and minerals. Because of the thinness of the gas accumulation, no development is likely.

South half of section 21 - The Morrow isolith maps show that there is no accumulation of gas sands in this spacing unit. The land is unleased, and is designated to be stipulated NSO on any future leases. No development is likely.

South half of section 22 - The Morrow isolith maps show that any accumulations of gas, if any, are likely to be located in the extreme eastern portion of the spacing unit. This would place the drill site very close to both Big and Little Manhole Caves. The site would also be very close to the #1 Guadalupe Federal, drilled in the SENE of this section, which suffered the most severe lost circulation of any well within the Dark Canyon study area. This spacing unit is directly on trend with one of the main passageway orientations of Lechuguilla Cave, is transected by at least two lineaments, and is directly on top of the Guadalupe Ridge

Anticline. Topographic access to any location is limited, and a seasonal stipulation limits drilling to September 1 through May 31. Development of this spacing unit is unlikely.



REASONABLE FORESEEABLE DEVELOPMENT (RFD) and EXISTING/PROPOSED GAS PIPELINE MAP

DARK CANYON EIS

(From EIS team files, 1992)

Map A-1

NATURAL GAS PIPELINES

⊢━⊣	Existing Pipeline
━ ━	New Pipeline to RFD Wells
●	Potential Well Location
○	Potential Bottom Hole Location

APPENDIX B

ENHANCED PRECAUTIONARY OPERATIONS

APPENDIX B

ENHANCED PRECAUTIONARY OPERATIONS

The requirements discussed here are mitigative measures which will be included as conditions of approval for wells drilled within the Dark Canyon EIS study area under Alternatives C, D, and E. They have been reviewed by government agencies, the oil and gas industry, and the general public (letter: May 14, 1992) and have been modified based upon the comments received.

DRILLING PROGRAM

Surface and Intermediate Intervals - Fresh water would be used for the drilling fluid through the perched water zones (surface to about 350 feet deep). Compressed air would then be used for the drilling fluid in the unsaturated portion of the Capitan Reef Complex (approximately 350 to 1350 feet deep). Fresh water would be used to drill through the saturated portion of the Reef Complex (From 1350 to about 2400 feet deep). If a significant bit drop of 2 feet or more were to occur, or if 75% or more lost circulation of cuttings returns to the surface were to occur, drilling would stop. This could be an indication that a large void or even a cave were being intercepted. A video camera would then be lowered through this section for analysis (see Video Camera, below).

Discussion: Compressed air is less invasive than drilling with mud and should reduce the potential for contamination of formations in which caves are formed. The use of compressed air as a drilling fluid may actually speed up the drilling process. It has been used nation-wide, especially when drilling in formations which are under-pressured and water-sensitive. Compressed air is not used extensively in the Permian Basin due to increased equipment costs and because of the likelihood of encountering substantial water flows while drilling in the region. Equipment availability may present somewhat of a problem. There is a slight increased risk for fires and explosions. There may be fugitive dust while drilling with air.

Steel Pits - These would be used to obtain a "closed" drilling mud system instead of using surface reserve pits. Formation cuttings would be deposited into steel tanks and later hauled away.

Discussion: Steel pits would eliminate the need to excavate (and later reclaim) reserve pits, but cost more. Surface disturbance and impacts to surface resources would be minimized.

CASING PROGRAM

Intermediate Interval - The casing program would use 8 5/8" diameter, 32 pound/foot, grade K-55 casing, with long threads and couplings, as opposed to the 24 pound casing.

Discussion: Standards developed by the National Association of Corrosion Engineers (NACE Standard MR-01-75) would be exceeded in the determination of the quality of the steel casing recommended. This would reduce the action of corrosive agents on the casing and, thereby, reduce the likelihood of casing deterioration. Overall, this casing would have thicker walls, be more resilient, and be better able to contain pressures. The casing would be better able to retain its integrity in the borehole environment. This thicker casing would not be so heavy that it would introduce excessive axial stresses on the uppermost joints of casing and cause the casing to fail in tension. However, this casing would be about $4/foot more expensive than customarily used and may not be readily available.

CEMENTING PROGRAM

Surface and Intermediate Intervals - A "light" advance cement slurry would be used with nontoxic lost circulation additives followed by a "neat" (having no additives) tail cement slurry so that the cement may maintain compressive strength. A gypsum cement additive would be blended into both the advance and tail slurries to augment properties of obtaining a time-controlled set.

The proposed mitigation for cementing voids would depend on the situation and the void size. If a void were encountered, a determination would be made by the BLM operations specialist on-site, in consort with the Carlsbad Resource Area Manager and other specialists (see "Monitoring," in this appendix), as to whether a cave had been intercepted. If determined that a cave was not intercepted, decisions would then be made regarding cementing. The prospects available for cementing voids include: a staged cement job, as recommended by the Cave and Karst Area Task Force (1991), the use of various nontoxic lost circulation materials, such as cottonseed hulls and cellophane flakes, additives for the cement, and the use of pressure controlled (thixotropic) and time controlled (gypsum/resin, i.e., cal-seal or hydromite) setting cements.

For extreme cases, "one inching" would be used for remedial action. For this, a temperature survey would be run to determine the top of the cement and where the primary cement job failed to provide complete coverage behind the intermediate casing. A one-inch pipe would be run down the annulus outside the intermediate casing in an effort to "tag" the top of the cement. The remedial cementing would entail pumping cement containing nontoxic lost circulation materials and accelerators through this pipe in consecutive stages until the void is sealed and the annular space is cemented to the surface.

Discussion: This cementing program is designed to seal off the primary and secondary porosity features which may occur throughout the Reef Complex. The "neat" tail slurry would provide a higher compressive strength sheath surrounding the casing. This cementing method is more expensive and is used extensively throughout the Permian Basin when attempting to cement casing through zones which contain fresh-water resources.

Production Interval - Cement would be circulated behind the production casing to the surface using a two or three stage cementing program with light advance slurries and neat tail slurries. The staged cement job would allow the Delaware and other potentially productive horizons to be cemented in a manner which does not impose excessive hydrostatic pressures with respect to formation fracture pressures. This would result in a cement and steel "sandwich" through the potential cave occurrence zone.

Discussion: Because all potential hydrocarbon-bearing horizons would be effectively sealed off, the chance for corrosion of the casing and migration of production fluids is diminished. However, there are increased expenses for stage tools and cement. Equipment failure is possible and would then require remedial work such as perforating the casing to "squeeze" cement.

MONITORING & EVALUATION

MONITORING OF DRILLING OPERATIONS

On-Site Operations Engineer/Technician - BLM would provide an oil and gas operations expert on-site to monitor and evaluate the drilling, completion, and abandonment of wells within the Dark Canyon EIS study area. This person would be monitoring operations from the spudding (initial drilling) of the well through penetration of the Capitan Reef Complex and at key points within the production interval. The intermediate interval is where there are potential cave formations and an existing potable aquifer. A BLM operations expert would later witness proper plugging and abandonment of the well.

Bit drops and pump pressures would be especially monitored to evaluate lost circulation and voids (see "Drilling Program" and "Cementing Program" in this appendix) so that decisions are made that are environmentally prudent.

Discussion: BLM would incur all expenses associated with having an operations expert that is on-site 24 hours per day. The BLM representative on-site, in communication with the BLM Carlsbad Area Manager, would be able to make informed decisions to determine if a cave were being penetrated. There would also be assurance that the operator is complying with all of BLM's conditions of approval. BLM would also have additional information and experience for drilling in cave and karst areas to be used in protecting resources in future drilling requests.

Video Camera - If a significant lost circulation zone of over 75% were to be intercepted or if a bit drop of 2 feet or more were to occur, drilling would cease and a down-hole video camera would be sent downhole for evaluation purposes. At this point, the drilling expert, in communication with the BLM Carlsbad Resource Area Manager, would make a decision whether to continue drilling or not. If determined that a cave or cave passage were intercepted, then the well would be permanently plugged and abandoned. If determined that drilling can continue in an environmentally safe manner, then the BLM specialist would work with the operator in making decisions regarding how to mitigate the affects on the environment for regaining circulation.

Discussion: Research indicates that the camera tool is available for immediate use through at least one logging service company in the area and has been successfully employed in cased hole evaluation in the oil and gas industry. Because the borehole is being drilled with air through most of the potential cave formations, no liquids would be present to obscure the camera's view. Thus, the camera would be able to help evaluate the size of any vugs and fractures encountered. However, the camera could also be required to be used in a fresh water mud system from about 1,300 to 2,400 feet deep. Although industry has used the camera in such an environment, the fresh water may impair some of the resolution of the picture received in comparison with an air environment.

The use of this tool could increase information on the technology of successfully drilling in cave/karst environments. The tool would cost approximately $3,000 per run, (not including drilling rig standby costs), which is apparently not prohibitive. However, expenses could substantially increase should the camera be required for numerous successive runs.

Cement Bond Evaluation Tool - As discussed earlier, cementing is a key factor in protecting downhole resources from casing leaks over time. The adequacy of downhole casing-to-cement and cement-to-formation bonding can be evaluated by the use of a cement bond logging (CBL) tool, in order that remedial work may be completed on the cement. Other cement evaluation tools (CET) may be used as appropriate. The evaluation tool would be run through the surface, intermediate and production intervals. A minimum of 72 hours must transpire before conducting cement evaluation surveys to allow the cement to properly set so that optimum diagnostic results may be gained.

Discussion: Trouble spots can be identified where potential casing leaks and corrosion problems may occur in the future. This would be especially helpful in evaluating the multi-stage cementing program required for the production interval. There are increased costs to the operator to run a CBL tool through upper cased intervals of the well. Remedial cementing of the intermediate casing before the operator has penetrated productive horizons may cause additional costs. If the well were not a producer, the remedial cementing would be accomplished more cost effectively at the time the well was plugged and abandoned.

MONITORING OF PRODUCTION

Pressure gauges would be installed at the surface of the well which would monitor pressure build-up in the tubing-to-production casing annulus. Pressure gauges would be monitored on a regular basis (semi-annually) by BLM petroleum engineering technicians and a permanent gauge record kept in order to indicate trends in pressure behavior over time for detecting potential packer, tubing, and casing leaks.

Discussion: Although the gauges would be regularly checked, the integrity of the downhole hardware can be checked at other times if there were any suspicion of production fluid leaks. Gauges at the surface are an inexpensive and easily understood method for monitoring downhole leaks.

APPENDIX C

EXISTING LEASE STIPULATIONS

APPENDIX C

EXISTING LEASE STIPULATIONS

Listed below are stipulations included for each lease within the Dark Canyon EIS study area, and the date that each lease became effective, followed by the status of each lease.

TABLE C-1

EXISTING LEASE STATUS--EIS STUDY AREA

Lease Number	**Effective Date**	**Status**	**Stipulations**
NM-12829	1/1/71	Held by Production	None
NM-29203	2/1/77	"	*
NM-29414-A	2/1/77	"	None
NM-62161	8/1/85	Suspended	*
NM-81894	10/1/89	Non-producing, active	*
NM-85841	1/1/91	"	*
NM-85842	1/1/91	"	*
NM-86001	1/1/91	"	*
NM-86515	6/1/91	"	*

* See Appendix C for existing lease stipulations.

(**Source:** Dark Canyon EIS Project Files, 1992.)

NM-12829 - 1/1/71

There are no stipulations in addition to the standard terms and conditions of the lease agreement.

NM-29203 - 2/1/77

1. To maintain esthetic values, all semi-permanent and permanent facilities may require painting or camouflage to blend with the natural surroundings. The paint selection or method of camouflage will be subject to approval by the District Engineer, Geological Survey, with the concurrence of the District Manager, Bureau of Land Management.

Bureau of Land Management.

2. No occupancy or other surface disturbance will be allowed on slopes in excess of 45 percent, without written permission from the District Engineer, Geological Survey, with the concurrence of the District Manager, Bureau of Land Management.

3. Notwithstanding any provision of this lease to the contrary, any drilling, construction, or other operation on the leased lands that will disturb the surface thereof or otherwise affect the environment, hereinafter called "surface disturbing operation," conducted by lessee shall be subject, as set forth in this stipulation, to prior approval of such operation by the Area Oil and Gas Supervisor in consultation with appropriate surface management agency and to such reasonable conditions, no inconsistent with the purposes for which this lease is issued, as the Supervisor may require to protect the surface of the leased lands and the environment.

4. Prior to entry upon the land or the disturbance of the surface thereof for drilling or other purposes, lessee shall submit for approval two (2) copies of a map and explanation of the nature of the anticipated activity and surface disturbance to the District Engineer or Area Oil and Gas Supervisor, as appropriate, and will also furnish the appropriate surface management agency named above, with a copy of such map and explanation.

An environmental analysis will be made by the Geological Survey in consultation with the appropriate surface management agency for the purpose of assuring proper protection of the surface, the natural resources, the environment, existing improvements, and for assuring timely reclamation of disturbed lands.

5. Upon completion of said environmental analysis, the District Engineer or Area Oil and Gas Supervisor, as appropriate, shall notify lessee of the conditions, if any, to which the proposed surface disturbing operations will be subject.

Said conditions may relate to any of the following:

(a) Location of drilling or other exploratory or developmental operations or the manner in which they are to be conducted;

(b) Types of vehicles that may be used and area in which they may be used; and

(c) Manner or location in which improvements such as roads, buildings, pipelines, or other improvements are to be constructed.

6. No payment or other consideration will be made to other uses, licensees, permittees or lessees for any damage to or loss of

natural vegetation, wildlife, mineral material, or for soil disturbance occurring on national resource lands, which result from operation, development or construction activities carried out under the authority of this oil and gas lease.

7. The lessee shall assure that full compliance with the previous stipulations and terms, and all subsequent stipulations adopted, is made by all persons acting in his behalf, including designated operators, and by all his employees, contractors and subcontractors.

8. Drilling operations will not be conducted within 100 yards of any cave entrance or known passageway or other subterranean aspect.

9. No "sludge" oil disposal pits will be located within 200 yards of known surveyed cave entrances or underground passageways, or in other locations (as determined by the BLM) where the cave resources will be endangered by seeping oil or waste products. Such pits will not be located in sink holes, near fractures or cave entrances; all pits will be lined with an impervious material.

10. No drilling sites will be cleared in such a manner as to increase natural flow of water into a cave entrance or cave aspect.

NM-29414A - 2/1/77

There are no stipulations in addition to the standard terms and conditions of the lease agreement.

NM-62161 - 8/1/85

1. No drilling operations will be conducted within 300 feet of any known cave entrance, passage or significant karst feature or aspect. Necessary precautions will be taken during construction, drilling and rehabilitation of reserve and/or mud pits to protect any cave entrance, passage or significant karst feature of aspect.

2. No pits used in conjunction with production facilities will be located within 600 feet or any known cave entrance of underground passageway, or in locations where spills from pits will drain into subsurface karst features, including "sink holes." All pits will be lined with an impervious material.

3. No facilities or roads will be constructed which would increase or decrease the natural flow of water into a cave entrance, cave aspect, or karst area.

4. This stipulation may be modified when specifically approved in writing by the Bureau of Land Management.

NM-81894 - 10/1/89

1. No surface occupancy or use is allowed on the lands described below (legal subdivision or other description):

T. 24 S., R. 24 E., NMPM
Sec. 20: NW¼NE¼, NE¼NW¼NW¼,SW¼NW¼, S½NW¼NW¼, SW¼

For the purpose of:
(a) Protecting important natural and scenic values as discussed in the Carlsbad RMP.

If circumstances or relative resource values change or if the lessee demonstrates that operations can be conducted without causing unacceptable impacts, this stipulation may be waive, excepted, or modified by the authorized officer if such action is consistent with the provisions of the applicable Land Use Plan, or if not consistent, through a planning amendment. If the authorized officer determines that the waiver, exception, or modification is substantial, the waiver, exception, or modification will be subject to a 30-day public review period.

2. Surface occupancy or use is subject to the following special operating constraints.
(a) Restricted Surface Disturbance: All surface disturbance will be restricted to conform to constraints within designated Visual Resource Management (VRM) Classes.
(b) Limited ORV Use: All vehicular use will be restricted to designated or authorized access routes.

On the lands described below:

T. 24 S., R. 24 E., NMPM
Sec. 20: NW¼SE¼

For the purpose of:
(a) Protecting important natural and scenic values within Dark Canyon ACEC/Scenic Area (CRA SMA No. 4) as discussed in the Carlsbad RMP.

If circumstances or relative resource values change or if the lessee demonstrates that operations can be conducted without causing unacceptable impacts, this stipulation may be waived, excepted, or modified by the authorized officer if such action is consistent with the provisions; of the applicable Land Use Plan, or if not consistent, through a planning amendment. If the authorized officer determines that the waiver, exception, or modification is substantial, the waiver, exception, or modification will be subject to a 30-day public review period.

3. No surface use is allowed during the following time period(s); unless otherwise specified, this stipulation does not apply to operation and maintenance of production facilities.

(a) Restricted Surface Disturbance: Oil and gas activities, including exploration, drilling and other development activities will only be allowed during the period from September 15 through March 31 annually. This limitation does not apply to routine maintenance or operation of producing wells.

On the lands described below:

T. 24 S., R. 24 E., NMPM
Sec 20: NW¼SE¼

For the purpose of:

(a) Minimizing impacts to highly sensitive visual resource values during the peak visitor use season with Dark Canyon ACEC/Scenic Area (CRA SMA No. 4) as discussed in the Carlsbad RMP.

If circumstances or relative resource values change or if the lessee demonstrates that operations can be conducted without causing unacceptable impacts, this stipulation may be waived, excepted, or modified by the authorized officer if such action is consistent with the provisions of the applicable Land Use Plan, or if not consistent, through a planning amendment. If the authorized officer determines that the waiver, exception, or modification is substantial, the waiver, exception, or modification will be subject to a 30-day public review period.

4. Provisions of the Mineral Leasing Act (MLA) of 1920, as amended by the Federal Coal Leasing Amendments of 1976, affect an entity's qualifications to obtain an oil and gas lease. Section 2(a)(2)(A) of the MLA, 30 U.S.C. 201(a)(2)(A), requires that any entity that holds and has held a federal coal lease for 10 years beginning on or after August 4, 1976, and who is not producing coal in commercial quantities from each such lease, cannot qualify for the issuance of any other mineral lease granted under the MLA. Compliance by coal lessees with Section 2(a)(2)(A) is explained in 43 CFR 3472.

In accordance with the terms of this oil and gas lease with respect to compliance by the initial lessee with qualifications concerning federal coal lease holdings, all assignees and transferees are hereby notified that this oil and gas lease is subject to cancellation if: (1) the initial lessee as assignor or as transferror has falsely certified compliance with Section 2(a)(2)(A), or (2) because of a denial or disapproval by a State

Office of a pending coal action, i.e., arms-length assignment, relinquishment, or logical mining unit, the initial lessee as assignor or as transferor is no longer in compliance with Section 2(a)(2)(A). The assignee, sublessee, or transferee does not qualify as a bona fide purchaser and, thus, has no rights to bona fide purchaser protection in the event of cancellation of this lease due to noncompliance with Section 2(a)(2)(A).

Information regarding assignor, sublessor, or transferor compliance with Section 2(a)(2)(A) is contained in the lease case file as well as in other Bureau of Land Management records available through the State Office issuing this leases.

NM-85841 - 1/1/91

1. Provisions of the Mineral Leasing Act (MLA) of 1920, as amended by the Federal Coal Leasing Amendments of 1976, affect an entity's qualifications to obtain an oil and gas lease. Section 2(a)(2)(A) of the MLA, 30 U.S.C. 201(a)(2)(A), requires that any entity that holds and has held a Federal coal lease for 10 years beginning on or after August 4, 1976, and who is not producing coal in commercial quantities from each such lease, cannot qualify for the issuance of any other mineral lease granted under the MLA. Compliance by coal lessees with Section 2(a)(2)(A) is explained in 43 CFR 3472.

In accordance with the terms of this oil and gas lease with respect to compliance by the initial lessee with qualifications concerning federal coal lease holdings, all assignees and transferees are hereby notified that this oil and gas lease is subject to cancellation if: (1) the initial lessee as assignor or as transferor has falsely certified compliance with Section 2(a)(2)(A), or (2) because of a denial or disapproval by a State Office of a pending coal action, i.e., arms-length assignment, relinquishment, or logical mining unit, the initial lessee as assignor or as transferor is no longer in compliance with Section 2(a)(2)(A). The assignee or transferee does not qualify as a bona fide purchaser and, thus, has no rights to bona fide purchaser protection in the event of cancellation of this lease due to noncompliance with Section 2(a)(2)(A).

Information regarding assignor or transferor compliance with Section 2(a)(2)(A) is contained in the lease case file as well as in other Bureau of Land Management records available through the State Office issuing this lease.

2. No surface occupancy or use is allowed on the lands described below (legal subdivision or other description):

T. 24 S., R. 23 E., NMPM
   Sec. 33: NE, E2NW, NESE

Sec. 35: N2

For the purpose of:
- (a) Protecting important natural and scenic values as discussed in the Carlsbad RMP.

If circumstances or relative resource values change or if the lessee demonstrates that operations can be conducted without causing unacceptable impacts, this stipulation may be waived, excepted, or modified by the authorized officer if such action is consistent with the provisions of the applicable Land Use Plan, or if not consistent, through a planning amendment. If the authorized officer determines that the waiver, exception,modification is substantial, the waiver, exception, or modification will be subject to a 30-day public review period.

NM-85842 - 1/1/91

1. Provisions of the Mineral Leasing Act (MLA) of 1920, as amended by the Federal Coal Leasing Amendments of 1976, affect an entity's qualifications to obtain an oil and gas lease. Section 2(a)(2)(A) of the MLA, 30 U.S.C. 201(a)(2)(A), requires that any entity that holds and has held a Federal coal lease for 10 years beginning on or after August 4, 1976, and who is not producing coal in commercial quantities from each such lease, cannot qualify for the issuance of any other mineral lease granted under the MLA. Compliance by coal lessees with Section 2(a)(2)(A) is explained in 43 CFR 3472.

In accordance with the terms of this oil and gas lease with respect to compliance by the initial lessee with qualifications concerning Federal coal lease holdings, all assignees and transferees are hereby notified that this oil and gas lease is subject to cancellation if: (1) the initial lessee as assignor or as transferor has falsely certified compliance with Section 2(a)(2)(A), or (2) because of a denial or disapproval by a State Office of a pending coal action, i.e., arms-length assignment, relinquishment, or logical mining unit, the initial lessee as assignor or as transferor is no longer in compliance with Section 2(a)(2)(A). The assignee or transferee does not qualify as a bona fide purchaser and, thus, has no rights to bona fide purchaser protection in the event of cancellation of this lease due to noncompliance with Section 2(a)(2)(A).

Information regarding assignor or transferor compliance with Section 2(a)(2)(A) is contained in the lease case file as well as in other Bureau of Land Management records available through the State Office issuing this lease.

2. No surface occupancy or use is allowed on the lands described below (legal subdivision or other description):

T. 24 S., R. 23 E., NMPM
Sec. 34: All

For the purpose of:
(a) Protecting important natural and scenic values as discussed in the Carlsbad RMP.

If circumstances or relative resource values change or if the lessee demonstrates that operations can be conducted without causing unacceptable impacts, this stipulation may be waived, excepted, or modified by the authorized officer if such action is consistent with the provisions of the applicable Land Use Plan, or if not consistent, through a planning amendment. If the authorized officer determines that the waiver, exception, or modification is substantial, the waiver, exception, or modification will be subject to a 30-day public review period.

NM-86001 - 1/1/91

1. Provisions of the Mineral Leasing Act (MLA) of 1920, as amended by the Federal Coal Leasing Amendments of 1976, affect an entity's qualifications to obtain an oil and gas lease. Section 2(a)(2)(A) of the MLA, 30 U.S.C. 201(a)(2)(A), requires that any entity that holds and has held a Federal coal lease for 10 years beginning on or after August 4, 1976, and who is not producing coal in commercial quantities from each such lease, cannot qualify for the issuance of any other mineral lease granted under the MLA. Compliance by coal lessees with Section 2(a)(2)(A) is explained in 43 CFR 3472.

In accordance with the terms of this oil and gas lease with respect to compliance by the initial lessee with qualifications concerning Federal coal lease holdings, all assignees and transferees are hereby notified that this oil and gas lease is subject to cancellation if: (1) the initial lessee as assignor or as transferor has falsely certified compliance with Section 2(a)(2)(A), or (2) because of a denial or disapproval by a State Office of a pending coal action, i.e., arms-length assignment, relinquishment, or logical mining unit, the initial lessee as assignor or as transferor is no longer in compliance with Section 2(a)(2)(A). The assignee or transferee does not qualify as a bona fide purchaser and, thus, has no rights to bona fide purchaser protection in the event of cancellation of this lease due to noncompliance with Section 2(a)(2)(A).

Information regarding assignor or transferor compliance with Section 2(a)(2)(A) is contained in the lease case file as well as in other Bureau of Land Management records available through the State Office issuing this lease.

2. No surface occupancy or use is allowed on the lands described

below (legal subdivision or other description):

T. 24 S., R. 23 E., NMPM
Sec. 25: All

For the purpose of:
(a) Protecting important natural and scenic values as discussed in the Carlsbad RMP.

If circumstances or relative resource values change or if the lessee demonstrates that operations can be conducted without causing unacceptable impacts, this stipulation may be waived, excepted, or modified by the authorized officer if such action is consistent with the provisions of the applicable Land Use Plan, or if not consistent, through a planning amendment. If the authorized officer determines that the waiver, exception, or modification is substantial, the waiver, exception, or modification will be subject to a 30-day public review period.

NM-86515 - 6/1/91

1. Provisions of the Mineral Leasing Act (MLA) of 1920, as amended by the Federal Coal Leasing Amendments of 1976, affect an entity's qualifications to obtain an oil and gas lease. Section 2(a)(2)(A) of the MLA, 30 U.S.C. 201(a)(2)(A), requires that any entity that holds and has held a Federal coal lease for 10 years beginning on or after August 4, 1976, and who is not producing coal in commercial quantities from each such lease, cannot qualify for the issuance of any other mineral lease granted under the MLA. Compliance by coal lessees with Section 2(a)(2)(A) is explained in 43 CFR 3472.

In accordance with the terms of this oil and gas lease with respect to compliance by the initial lessee with qualifications concerning Federal coal lease holdings, all assignees and transferees are hereby notified that this oil and gas lease is subject to cancellation if: (1) the initial lessee as assignor or as transferor has falsely certified compliance with Section 2(a)(2)(A), or (2) because of a denial or disapproval by a State Office of a pending coal action, i.e., arms-length assignment, relinquishment, or logical mining unit, the initial lessee as assignor or as transferor is no longer in compliance with Section 2(a)(2)(A). The assignee or transferee does not qualify as a bona fide purchaser and, thus, has no rights to bona fide purchaser protection in the event of cancellation of this lease due to noncompliance with Section 2(a)(2)(A).

Information regarding assignor or transferor compliance with Section 2(a)(2)(A) is contained in the lease case file as well as in other Bureau of Land Management records available through the

State Office issuing this lease.

2. No surface occupancy or use is allowed on the lands described below (legal subdivision or other description):

T. 24 S., R. 23 E., NMPM
Sec. 24: S2SWSW, SESW, NESE, S2NWSE, S2SE

For the purpose of:
(a) Protecting important natural and scenic values as discussed in the Carlsbad RMP.

If circumstances or relative resource values change or if the lessee demonstrates that operations can be conducted without causing unacceptable impacts, this stipulation may be waived, excepted, or modified by the authorized officer if such action is consistent with the provisions of the applicable Land Use Plan, or if not consistent, through a planning amendment. If the authorized officer determines that the waiver, exception, or modification is substantial, the waiver, exception, or modification will be subject to a 30-day public review period.

3. All or portion of lease are located in a potential cave or karst occurrence area. Within this area, caves or karst features such as sinkholes, passages, and large rooms may be encountered from the surface to a depth of as much as 2,000 feet, within surface areas ranging from a few acres to hundreds of acres. Due to the sensitive nature of the cave or karst systems of this area, special protective measures may be developed during environmental analyses and be required as part of approvals for drilling or other operations on this lease. These measures could include: changes in drilling operations; special casing and cementing programs; modifications in surface activities; or other reasonable measures to mitigate impacts to cave or karst values. These measures may be imposed in accordance with 43 CFR 3101.1-2; 43 CFR 3162.5-1; Onshore Oil and Gas Order No. 1; and Section 6 of the lease terms.

APPENDIX D

VEGETATION, WILDLIFE AND SPECIAL STATUS SPECIES

D-1: Mitigative Measures for Special Status Species
D-2: Species Lists

APPENDIX D-1

LEASE NOTICE R47-- MITIGATIVE MEASURES FOR SPECIAL STATUS SPECIES

This document (R-47) would be added as a stipulation for new leases ans as a condition of approval for drilling within the Dark Canyon EIS study area.

Lease Notice

Protection of Endangered or Threatened or Sensitive Species

The following species have been identified as occurring on or in the vicinity of the lease areas. The lease areas may contain essential habitat for the continued existence of these species (see attached list or insert species name here).

The Bureau of Land Management (BLM) is responsible for assuring that the leased lands are examined prior to undertaking any surface disturbing activities on lands covered by these leases, to determine effects on any plant or animal species listed or proposed for listing as endangered or threatened or their habitat.

In accordance with Section 6 of the lease terms and in order to comply with the Endangered Species Act of 1973 the Lessee may be required to conduct an examination on the lands (including access routes to the leases areas) to be affected by the proposed action to determine if threatened or endangered species are present or may be affected by the proposed action. This survey would be done by resource specialists approved by the BLM. An acceptable report is to be submitted for approval to the BLM identifying the anticipated effects of the proposed action on endangered or threatened species and their habitat. If the examination determines that the action may detrimentally affect a species listed or proposed for listing as an endangered or threatened species, restrictions to the Lessee's proposal or even denial of any beneficial use of the lease may result. The Lessee will take such measures as may be required by the authorized officer to protect such species.

APPENDIX D-2

SPECIES LIST

MAMMAL LIST FOR DARK CANYON ACEC

Species	Ridge Tops	Canyon Bottom	
(Fringed Myotis) (*Myotis thysanodes*)	X	X	
(California Myotis) (*Myotis Californicus*)		X	X
(Western Pipistrelle) (*Pipistrellus hesperus*)		X	X
Pallid Bat (*Antrozous pallidus*)		UC	
Brazilian Free-tailed Bat (*Tadarida brasiliensis*)	C	C	
Desert Cottontail (*Sylvilagus auduboni*)	UC	C	
Black-tailed Jackrabbit (*Lepus californicus*)		C	C
Rock Squirrel (*Spermophilus variegatus*)	C	C	
Botta's Pocket Gopher (*Thomomys bottae*)	C		
(Silky Pocket Mouse) (*Perognathus flavus*)		X	X
(Cactus Mouse) (*Peromyscus eremicus*)		X	
(White-footed Mouse) (*Peromyscus leucopus*)		X	X
(Southern Grasshopper Mouse) (*Onychomys torridus*)		X	
White-throated Woodrat (*Neotoma albigula*)		R	
Porcupine (*Erethizon dorsatum*)		UC	
Coyote (*Canis latrans*)	UC	C	
(Gray Wolf) (*Canis lupus*)	EXTIRPATED	X	X
Gray Fox (*Urocyon cinereoargenteus*)		UC	
Ringtail (*Bassariscus astutus*)	R	UC	
Raccoon (*Procyon lotor*)		C	
(Long-tailed Weasel) (*Mustela frenata*)	X	X	
Striped Skunk (*Mephitis mephitis*)		C	
Hog-nosed Skunk (*Conepatus mesoleucus*)		C	
Mountain Lion (*Felis concolor*)		C	
Mule Deer (*Odocoileus hemionus*)	C	C	
Barbary Sheep (*Ammotragus lervia*)	INTRODUCED		UC

C: Refers to status in which track, scat or individuals were seen on at least 75% of the trips to the study area.

UC: Refers to status in which track, scat or individuals were seen from 25-74% of the trips to the study area.

R: Refers to status in which track, scat or individuals were seen on less than 25% of the trips to the study area.

X: Species that probably occur or formerly occurred but considered extirpated today.

BIRD LIST FOR DARK CANYON ACEC

Species	Seasonal Status	Upland	Xero-Riparian
Turkey Vulture	SP-FA	C	C
Red-tailed Hawk*	P	C	C
Golden Eagle	P	UC	UC
American Kestrel	FA-SP	UC	UC
Scaled Quail*	P		R
Killdeer	P		R
Spotted Sandpiper	W		R
Upland Sandpiper	FA	R	
Mourning Dove	P	UC	C
Greater Roadrunner	P		R
Great Horned Owl*	P		UC
Common Nighthawk	SP-FA	C	C
Common Poorwill	SP-FA	UC	
White-throated Swift	P	UC	
Black-chinned Hummingbird*	SP-FA		UC
Ladder-backed Woodpecker*	P	UC	C
Northern (r-s) Flicker	W		R
Western Wood Pewee	SP/FA	UC	C
Say's Phoebe*	P	UC	C
Ash-throated Flycatcher	SP-FA	C	C
Western Kingbird	SP,FA	R	R
Cliff Swallow*	SP-FA	C	C
Cave Swallow*	SP-FA	C	C
Scrub Jay	FA	R	
Pinyon Jay	W	R	
Cactus Wren	P		C
Rock Wren*	P	UC	C
Canyon Wren	P		C
Bewick's Wren	P	UC	UC
Ruby-crowned Kinglet	FA-SP	UC	UC
Western Bluebird	W	R	R
Mountain Bluebird	W	R	R
Townsend's Solitaire	W	R	R
Hermit Thrush	W	R	R
American Robin	SP	R	
Northern Mockingbird*	P	R	C
Sage Thrasher	FA-SP	C	UC
Curve-billed Thrasher	P	C	C
American Pipit	FA-SP	R	
Bell's Vireo	SP-FA		R

Gray Vireo SP R

Species	**Seasonal Status**	**Upland**	**Xero-Riparian**
Yellow-rumped (A) Warbler	FA-SP		UC
Wilson's Warbler	SP/FA		UC
Summer Tanager	SU		R
Pyrrhuloxia*	P		C
Blue Grosbeak*	SP-FA		UC
Green-tailed Towhee	W		R
Rufous-sided Towhee	FA-SP	UC	C
Canyon Towhee	P	C	C
Rufous-crowned Sparrow*	P	C	C
Chipping Sparrow	FA-SP	UC	C
Brewer's Sparrow	FA-SP		UC
Field Sparrow	W		R
Black-chinned Sparrow	W		R
Vesper's Sparrow	FA-SP		C
Black-throated Sparrow*	P	C	C
Lark Bunting	FA-SP	UC	UC
White-crowned Sparrow	FA-SP	C	C
Dark-eyed (Oregon) Junco	W	UC	UC
Dark-eyed (pink-sided) Junco	FA-SP	C	C
Dark-eyed (gray-headed) Junco	W		R
Eastern Meadowlark	P	UC	UC
Western Meadowlark	FA-SP	R	R
Brown-headed Cowbird	P	UC	C
Scott's Oriole*	SP-FA	C	UC
House Finch*	P	UC	UC
Lesser Goldfinch	P		UC

Explanation of Symbols Used:

* = Nesting activity in the area either of an active nest with eggs or young or dependent young accompanied by one or both parents.

Season Status:

P = Permanent resident
SP = Spring migration
SU = Summer
FA = Fall migration
W = Winter

SP,FA = species that passes through the area in spring and fall.
SP-FA = species that occurs from spring through fall.
FA-SP = species that migrates to the area in the fall, winters over and leaves in the spring.

Occurrence Status:

C = Common - recorded on at least 30-100% of trips to the area
UC = Uncommon - recorded on at 10-30% of trips to the area
R = Rare - recorded on less than 10% of trips to the area

HERPETOFAUNA LIST FOR DARK CANYON ACEC

Canyon **Species** **Bottom**	**Ridge** **Tops**	
(Texas Banded Gecko) (Coleonyx brevis)	X	X
Crevice Spinty Lizard (Sceloporus poinsetti)	C	UC
Eatern Fence Lizard (Sceloporus undulatus)	C	
Tree Lizard (Urosaurus ornatus)	UC	R
Round-tailed Horned Lizard (Phrynosoma modestum)	R	
Coachwhip (Masticophis flagellum)	R	
Striped Whipsnake (Masticophis taeniatus)		UC
(Trans-Pecos Rat Snake) (Elaphe subocularis)	X	X
Gopher Snake (Pituophis melanopleucus)	R	
Western Damondback Rattlesnake (Crotalus atrox)	UC	UC
(Black-tailed Rattlesnake) (Crotalus molussus)	X	X

C: Refers to status in which individuals were seen on 75% of trips to the study area.

UC: Refers to status in which individuals were seen on 25-74% of trips to the study area.

R: Refers to status in which individuals were seen on less than 25% of trips to the study area.

X: Species that probably occur but were not observed during this survey.

(**Source:** The Nature Conservancy, *"Biological Inventory Report for the Dark Canyon ACEC,"* 1990. In the BLM Carlsbad Resource Area files.)

APPENDIX E

VISUAL RESOURCES

E-1: Mitigation of Impacts to Visual Resources
E-2: Visual Resource Management Ratings

APPENDIX E-1

MITIGATION OF IMPACTS TO VISUAL RESOURCES

The requirements discussed here are mitigative measures for visual resources which would be included as conditions of approval for wells drilled within the Dark Canyon EIS study area, for all development alternatives (A, C, D, and E). These would be required for VRM Class II, and modified for VRM Class III areas.

- Require collection, stockpile, and protection of top soils and major plant materials for use in reclamation work.
- Upon completion of wells, recontour and revegetate all disturbed areas unnecessary for well production using stockpiled soils and vegetation.
- Require a selfcontained venting system to recover all fugitive or vented gas or vapors.
- Require all production facilities to be low profile, i.e., less than 6 feet tall.
- Require special painting on all facilities to help blend the appearance of the facilities into the natural surroundings. Camouflage painting is an option.
- Special berming as a visual screen may be required.
- Special chemicals to chemically weather any exposed mineral materials used in pad construction for initial reclamation (after drilling) and for final reclamation (if a well were determined to be unproductive).
- Motors and pumps will have "hospital quiet" mufflers.
- Electric power will be supplied by photo voltaic cells and not by electric power lines.
- All pipelines will be buried a minimum of 40 inches below the surface at road crossings and under drainages.
- Maximum driving surface for roads will be twelve feet, with a maximum total width of fourteen feet.
- Any extra mineral materials used in pad construction or road building will be hauled off site during reclamation.

APPENDIX E-2

VISUAL RESOURCE MANAGEMENT RATINGS

Form 8400-4
(September 1985)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

VISUAL CONTRAST RATING WORKSHEET

Date

District
Roswell

Resource Area
CRA

Activity (program)
Gas Well

SECTION A. PROJECT INFORMATION

1. Project Name
Diamond Back #1

2. Key Observation Point
#1

3. VRM Class
II

4. Location
Township 24
Range 24
Section 19
SWNESE¼

5. Location Sketch
See Map #2
attachment

SECTION B. CHARACTERISTIC LANDSCAPE DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	Rolling to steep rugged - jagged	Flowing irregular bold cliffs - curving	Flat linear narrow road
LINE	Rounded - high vertical - complex	Rolling, curving diagonal - vertical	Curving - continuing
COLOR	Tan - light	Green	Light Green
TEXTURE	Medium - coarse	Coarse dense - continuous	Medium - smooth

SECTION C. PROPOSED ACTIVITY DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	Flat	Linear - geometrical forms created by clearings	Cylindrical, angular, long
LINE	Horizontal - pad curved (road)	Straight edge effect	Vertical, angular horizontal
COLOR	White - beige	Light green	Tan
TEXTURE	Smooth	Patchy	Smooth

SECTION D. CONTRAST RATING ☐ SHORT TERM ☐ LONG TERM

1. DEGREE OF CONTRAST

	FEATURES											
	LAND/WATER BODY (1)				VEGETATION (2)				STRUCTURES (3)			
ELEMENTS	Strong	Moderate	Weak	None	Strong	Moderate	Weak	None	Strong	Moderate	Weak	None
Form	X				X					X		
Line	X				X				X			
Color		X					X				X	
Texture	X					X					X	

2. Does project design meet visual resource management objectives? ☐ Yes ☒ No (Explain on reverse side)

3. Additional mitigating measures recommended ☒ Yes ☐ No (Explain on reverse side)

Evaluators Names

Date

Form 8400-4
(September 1985)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

VISUAL CONTRAST RATING WORKSHEET

Date

District: Roswell

Resource Area: CRA

Activity (program): Gas Well & Road

SECTION A. PROJECT INFORMATION

1. Project Name: Diamond Back Fed. #1
2. Key Observation Point: #3
3. VRM Class: II

4. Location
Township 24
Range 24
Section 19

5. Location Sketch: See Map Attached

SECTION B. CHARACTERISTIC LANDSCAPE DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	Horizontal horizon curving drainage	Patchy, irregular spotty, diagonal	(Road) curving, flat
LINE	Curve-linear to straight angular-rounded valley hill tops	Curving non-drectional	(Road) straight - curving
COLOR	Limestone - gray - orange - weatherings	Deep green - lighter green	(Road) light brown to beige
TEXTURE	Medium - coarse	Coarse, medium	Smooth (road)

SECTION C. PROPOSED ACTIVITY DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	Flat - square		Vertical - horizontal flat - square - cylindrical
LINE	Horizontal straight		Straight - regular geometric
COLOR	White to beige		Tan - beige
TEXTURE	Smooth		Smooth

SECTION D. CONTRAST RATING ☐ SHORT TERM ☒ LONG TERM

1.

DEGREE OF CONTRAST		LAND/WATER BODY (1)				VEGETATION (2)				STRUCTURES (3)			
		Strong	Moderate	Weak	None	Strong	Moderate	Weak	None	Strong	Moderate	Weak	None
ELEMENTS	Form		X			X				X			
	Line	X				X				X			
	Color	X				X				X			
	Texture	X				X					X		

2. Does project design meet visual resource management objectives? ☐ Yes ☒ No (Explain on reverse side)

3. Additional mitigating measures recommended ☒ Yes ☐ No (Explain on reverse side)

Evaluators Names | Date

Form 8400-4
(September 1985)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

VISUAL CONTRAST RATING WORKSHEET

Date

District
Roswell

Resource Area
CRA

Activity (program)
Natural Gas Well

SECTION A. PROJECT INFORMATION

1. Project Name
Diamond Back Fed. #1

2. Key Observation Point
#2

3. VRM Class
II

4. Location
Township 24
Range 24
Section 19
SWNESE¼

5. Location Sketch
See attachment map #1

SECTION B. CHARACTERISTIC LANDSCAPE DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	Rolling to steep rugged - jagged	Flowing terrain, bold cliffs, curving, dense	Flat linear narrow road
LINE	Rounded - high vertical - complex	Rolling, curving diagonal - vertical	Curving - continuous
COLOR	Tan - light brown - gray - cliffs	Green	Light brown
TEXTURE	Medium - coarse	Dense coarse - continuous	Medium

SECTION C. PROPOSED ACTIVITY DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	Square, flat wide - angular	Linear, square long, flattened	Tall, cylindrical square - rectangular
LINE	Horizontal straight, smooth	Straight	Straight, vertical angular, horizontal
COLOR	White	No vegetation removed	White - beige
TEXTURE	Smooth	----	Smooth

SECTION D. CONTRAST RATING ☐ SHORT TERM ☐ LONG TERM

1. DEGREE OF CONTRAST		FEATURES											
		LAND/WATER BODY (1)				VEGETATION (2)				STRUCTURES (3)			
		Strong	Moderate	Weak	None	Strong	Moderate	Weak	None	Strong	Moderate	Weak	None
ELEMENTS	Form	X					X				X		
	Line	X					X				X		
	Color	X				X						X	
	Texture	X				X						X	

2. Does project design meet visual resource management objectives? ☐ Yes ☒ No (Explain on reverse side)

3. Additional mitigating measures recommended ☒ Yes ☐ No (Explain on reverse side)

Evaluators Names Date

APPENDIX F

WATER RESOURCES

APPENDIX F
WATER RESOURCES

ANALYTICAL DETERMINATION FOR POTENTIAL CONTAMINATION BY BRINES
(Compiled by Dark Canyon EIS Team, 1992)

Summary: Drill-stem tests of gas wells in and near the Dark Canyon EIS study area were evaluated to determine whether plugged gas wells, if they were to leak, could contaminate the Capitan aquifer with brine. **Results of this analysis indicate that it appears unlikely that large quantities of brine would move into the Capitan aquifer from the underlying units.**

Discussion: For the purposes of this analysis, it was assumed that slow leaks in the casing and plugs would allow the brine to rise in the borehole at a rate slow enough that the brine would cool from the reported bottom-hole temperature to a temperature equal to the existing temperature in the borehole. The water level in the Capitan aquifer was assumed to be a constant 3100 feet above sea level. The pressure at the depth of the drill-stem test is then:

$$p = (sfw \times l) + (ssw\,(d-l)) \qquad (1)$$

where:

p = pressure at the depth of the drill-stem test (initial shut-in pressure was used), in pounds per square inch,

sfw = specific weight of fresh water in the Capitan aquifer, assumed to be 0.434 pounds per square inch per foot,

l = length of the fresh water column, in feet below the water level in the Capitan aquifer,

ssw = specific weight of brine in the zone tested,

d = length of the entire fluid column, from the water level in the Capitan aquifer to the depth of the zone tested.

Equation (1) can be solved for l, the depth of the interface below the water level:

$$l = ((ssw \times d) - p)/(ssw - sfw) \qquad (2)$$

The depth to the interface is the sum of the depth to water in the Capitan aquifer and the depth of the interface below the water level. The specific weight of the brine column was determined by converting the reported chloride concentration to an equivalent weight percent of sodium chloride, and estimating the average temperature of the brine column as the average of the reported bottom-hole temperature and the temperature in the Capitan aquifer, assumed to be 21 degrees Celsius. The average temperatures were close to 50 degrees Celsius for all the tests, so this temperature was assumed throughout. The specific weight was then determined from tables of density of sodium chloride solutions for a range of temperatures and pressures given in Potter and Brown (1977).

The results of the calculations are given in Table F-1 below for wells in and near the EIS study area. The depth to the interface is compared with the reported or estimated depth to the base of the Capitan aquifer. The first test is the defining test for the Baldrige Canyon gas field, as reported by Fisco (1988). The predevelopment pressure in the Morrow would have been inadequate to raise the interface to the base of the Capitan aquifer. Subsequent tests in wells 3 and 6 showed that the interface would be even lower in the developed field. A test of the Strawn in well 2 indicates that the interface would be close to the base of the Capitan aquifer, and a test of an unreported unit in well 5 might have an interface elevation above 1100 feet, however this unit was greatly depleted during the test and had a large uncertainty in the estimated temperature. The test of the relatively fresh water from the Delaware sandstone in well 6 had a pressure that was not adequate to raise the water level to the estimated regional water level in the Capitan aquifer, thus saline water flow is unlikely from this unit at this location.

The depth of the interface is very sensitive to the difference between the specific weight of fresh water and brine, as indicated by equation (2). Because the chloride content of the brine is uncertain, and because the temperature gradient in the borehole is estimated, the specific weight of the brine may be in error, causing larger errors in the estimates of interface depth. Thus, the results in Table F-1 should be used with caution. However, because the loss in head required to move brine through the borehole and plugs is not considered, and because continued development of gas in the Baldrige Canyon field would continue to reduce the pressure in lower units, **it appears unlikely that large quantities of brine would move into the Capitan aquifer from the underlying units.**

TABLE F-1

DRILL STEM TESTS IN AND NEAR THE DARK CANYON EIS STUDY AREA

Definitions:

Well: Well number used for this table.
Depth: Depth of the top and bottom packer settings for the drill-stem test.
Unit: The unit reported tested.
Penn.: Pennsylvanian limestone.
Dela.: Delaware sandstone.
Elev.: Elevation of the land surface at the well, in feet above sea level.
ISIP: Initial shut-in pressure, in pounds per square inch.
FSIP: Final shut-in pressure, in pounds per square inch.
Chloride: The reported chloride content of the fluid recovered, in parts per million.
Temp.: Bottom-hole temperature, in degrees centigrade.
Wt. : Average specific weight of the saline water in the borehole, in pounds per square inch, per foot of fluid in the borehole.
Interface: Calculated depth to the interface between fresh and saline water in the borehole, assuming the borehole communicates with both the Capitan aquifer and the zone tested, and assuming a fresh water level elevation of 3100 feet above sea level in the Capitan aquifer.
Base Capitan: Depth to the base of the Capitan aquifer, in feet.
NR: not reported, values in parentheses are estimated, > = depths are greater than the depth of the test (zone tested is underpressured).

Well	Depth	Unit	Elev.	ISIP	FSIP	Chloride	Temp.	Sp.Wt	Inter face	Base Capitan
1	10,780-10,945	Morrow	4428	4253	4220	63,000	78	0.467	6200	3806
2	9780-9860	Strawn	4518	3938		NR		(0.488)	4060	(3900)
3	10,280-10,442	Morrow	4242	4066		88,000	75	0.467	7904	(3600)
4	9322-9375	Penn.	4388	4264	4040	112,000	NR	(0.494)	<1144	3192
5	8315-8377	NR	4050	3312		74,000	NR	(0.474)	5425	2596
6	3956-4123	Dela.	4643	1249		2,900	50	(0.434)	>	3328
6	10,770-10,882	Morrow	4643	3800	3773	45,000	NR	(0.456)	>	3328

7	9840-9910	Strawn	4639	3947	4002	125,000	92	0.489	>	(2240)

Well	Name	Well Number
1	W. A. Moncrief, Jr., Baldrige Can. Fed. Com 1	24.24.13.234
2	W. A. Moncrief, Jr., Baldrige Can. Fed. 1	24.24.14.412
3	W. A. Moncrief, Jr., Baldrige Can. Fed. 2	24.24.14.212
4	W. A. Moncrief, Jr., Lechuguilla Can. 5	24.24.15.143
5	C and K Petroleum Corp, Lowe St. 1	24.24.16.123
6	W. A. Moncrief, Jr., Guadalupe Fed. 1	24.24.22.242
7	W. A. Moncrief, Jr., Ridge Fed. 1	24.24.23.121

TABLE F-2

ELEVATIONS OF CAVITIES AND LOST-CIRCULATION ZONES

(Compiled by Dark Canyon EIS Team from Sources Listed Below, 1992)

Listed below are wells which have been interpreted to have intercepted cavities, lost circulation zones, or have had cementing problems. The definitions for the terms used precede the table.

Well Name: Name of the operator and well in the well record or other source.

Well Number: The number is based on the numbering system of the New Mexico State Engineer Office. For instance, well 21.26.31.241 is in the northwest quarter of the southeast quarter of the northeast quarter of Section 31, Township 21 south, Range 26 east.

Surface Elevation: The average elevation of the land surface near the well, in feet above sea level.

Cavity Depth: Depth of the cavity, lost-circulation zone, top of cement, or porous zone, in feet below land surface.

Cavity Elevation: Elevation of the cavity, lost-circulation zone, top of cement, or porous zone, in feet above sea level.

Type: The type of zone encountered; CA = cavity or crevice, LC = lost-circulation zone, TC = top of cement, when cement did not circulate to the surface, PZ = zone of increased porosity from borehole geophysical logs.

Source: Source of records used; BM = Bjorklund and Motts, 1959, HJ = Hendrickson and Jones, 1952, WR = well completion or cementing records submitted to the Bureau of Land Management, U. S. Geological Survey, or New Mexico Oil Conservation Commission, TF = report of the Cave and Karst Task Force, CNL = borehole-compensated neutron porosity log, DTB = reported drilling-time break, SL = sonic log.

Well Name	Well Number	Surface Elevation	Depth	Cavity Elevation	Type	Source
Bobbit Well Water Well	21.26.31.241	3306	611	2695	CA	HJ
Nat. Stock Well	22.22.32.344	4560	898	3662	CA	HJ

Water Well						
Discovery Co.	22.24.05.414	4286	146	4140	LC	WR
Walt Can. 5 Fed. 1			369	3917	LC	WR
John H. Trigg	22.24.06.111	3935	719	3216	TC	WR
Fed. IB 1-6						
Superior Oil Co.	22.24.19.110	4578	200	4378	CA	WR
Cone Butte 1			1500	3078	TC	WR
James E. Logan	22.24.24.234	3997	418	3579	TC	WR
Rain Spring 1						
Gulf Oil Corp.	22.24.26.323	4081?	70	4011	CA	WR
Truitt Ranch 1			94	3987	CA	WR
			120	3961	CA	WR
			148	3933	CA	WR
Atlan. Richfield	22.25.06.112	3741	1428	2313	TC	WR
Walt Canyon 3						
Pennzoil Un. Inc.	22.25.08.421	3590	45	3545	TC	WR
Annie Brown 1			800	2790	TC	WR
Belco Pet. Corp.	22.25.16.213	3708.4	917	2791	LC	WR
Pennzoil State 1						
Belco Pet. Corp.	22.25.16.324	3628	630	2998	TC	WR
Pennzoil State 2						
Siete O & G Co.	22.25.17.133	3830?	247	3853	LC	WR
Blackfoot Fed. 1			297	3533	TC	WR
			815	3015	LC	WR
			1763	2067	LC	WR
Morris Antweil	22.25.19.412	3736	910	2826	LC	WR
Indian Wells 1						
Siete O & G Co.	22.25.21.413	3610?	180	3430	LC	WR
Apache Fed. 1			202	3408	TC	WR
			253	3357	TC	WR
			1088	2522	TC	WR
			1125	2485	LC	WR
Coquina Oil Corp.	22.25.23.422	3440	707	2733	TC	WR
FAF Fed. 1						
Glenn Cope	22.25.30.224	3752	334	3418	LC	WR
Fed. 30 Com 1						
Monsanto Co.	22.25.30.413	3869	1300	2569	TC	WR
Stein Fed. 1						
Bluebird Oil Co.	22.26.03.214	3240	65	3175	CA	BM
Bluebird Well			345	2895	CA	BM
			535	2705	CA	BM
Morris Antweil	22.26.03.231	3220	304	2880	LC/TC	WR
Valle Feliz 1						
Amoco Prod. Co.	22.26.09.323	3353.6	440	2914	TC	WR

Lancaster Spr. Com 1			1340+	<2014	TC	WR
Prim. Fuels Inc.	22.26.19.141	3409.1	206	3203	TC	WR
Amoco 19 Fed. 4			650	2759	LC	WR
			865	2544	TC	WR
Prim. Fuels Inc.	22.26.19.231	3384.7	665	2720	TC	WR
Amoco Fed. 3						
Windham Well	22.26.20.312	3346	200	3146	CA	HJ
Water Well						
Chevron USA, Inc.	22.26.21.413	3350?	301	3049	LC	WR
Lee K Fed. 1			318	3032	TC	WR
			900	2450	LC	WR
Internorth, Inc.	23.24.06.242	4243.2	166	4077	LC	WR
Azotea Mesa Fed. 1			230	4013	TC	WR
Cities Serv. Oil	23.24.08.322	4310	62	4248	TC	WR
Azotea Mesa Fed. 1			142	4168	TC	WR
Amoco Prod. Co.	23.24.17.211	4239	120	4119	TC	WR
Fed. BL 1						
Exxon Corp.	23.24.25.322	3853	788	3065	TC	WR
Ross Fed. 1						
Yates Pet. Corp.	23.24.27.413	3860	83	3777	LC	WR
Crooked Creek Com 1			360	3500	LC	WR
			378	3482	LC	WR
Exxon Corp.	23.25.01.312	3695	34	3661	TC	WR
Squaw Fed. 3			203	3492	LC	WR
			480	3215	TC	WR
			544	3151	LC	WR
			610	3085	TC	WR
			710	2985	TC	WR
Hanagan Pet. Co.	23.25.11.242	3724	330	3394	TC	WR
Sheep Draw 1			610	3114	TC	WR
Exxon Corp.	23.25.24.242	3446	240	3206	TC	WR
Mary Fed. 4			318	3128	TC	WR
			346	3100	TC	WR
			390	3056	TC	WR
			689	2757	TC	WR
			762	2684	TC	WR
			892	2554	TC	WR
			1038	2408	TC	WR
Amoco Prod. Co.	23.25.31.343	3881.1	500	3381	TC	WR
State IB Com 1						
Exxon Corp.	23.25.36.421	3868	1384	2484	CA	WR
ER State 1			1390	2478	TC	WR
Humble Oil Co.	23.26.31.124	3765	390	3375	TC	WR
North White City 1			420	3345	TC	WR
			520	3245	TC	WR
Union Oil Co.	24.22.17.114	5690	226	5464	CA	WR

Fed White 1						
Franklin, A & F	24.22.31.231	5828.3	340	5488	LC/TC	WR
Turkey Draw 1			1207	4621	TC	WR
Inexco Oil Co.	24.23.04.412	4399.2	125	4274	TC	WR
Goodwin State 1						
Yates Pet. Corp.	24.23.25.324	4517	273	4244	TC	WR
Serpentine Bends 1			1050	3467	TC	WR
Humble Oil Co.	24.23.30.432	5303	35	5268	LC	WR
Huapache Unit 12						
Gulf Oil Corp.	24.24.09.342	4038	80	3958	TC	WR
Franklin Fed. 1			260	3778	LC	WR
Yates Pet. Corp.	24.24.10.322	4177	1110	3067	PZ	CNL
Lechuguilla Can. BP Fed. 1						
Meridian Oil Inc.	24.24.12.234	4032	680	3352	LC	WR
Jurnegan State Com 2						
W.A. Moncrief Jr.	24.24.13.234	4428	1230	3198	LC	TF
Baldrige Can. Fed. Com 1						
W.A. Moncrief Jr.	24.24.14.212	4242	719	3523	LC	WR
Baldrige Can. Fed. 2			985	3257	TC	WR
W.A. Moncrief Jr.	24.24.15.143	4388	122	4266	LC	TF
Lechuguilla Can. 5			160	4228	LC	TF
Water Well Test	24.24.16.442	4430	1115	3315	CA	WR
Test Well						
Stock Well	24.24.19.434	4380	600	3780	LC	WR
Rock Bottom Well						
Yates En. Corp.	24.24.20.143	4277.6	66	4212	LC	WR
Sidewinder 1						
W.A. Moncrief Jr.	24.24.22.242	4643	239	4404	LC	TF
Guadalupe Fed. 1			371	4272	TC	TF
			418	4225	LC	WR
			1120	3523	LC	TF
			1324	3319	TC	WR
			1570	3073	PZ	CNL
			1815	2828	PZ	CNL
			1870	2773	PZ	CNL
			1910	2733	PZ	CNL
			2065	2578	PZ	CNL
			2195	2448	PZ	CNL
W.A. Moncrief Jr.	24.24.22.244	4643	1770	2873	PZ	DTB
Water Well Test			1791	2852	PZ	DTB
W.A. Moncrief Jr.	24.24.23.121	4639	300	4339	LC	TF
Ridge Fed. 1			455	4184	LC	TF
			1460	3179	TC	WR
			1680	2959	PZ	CNL
			1770	2869	PZ	CNL

Inexco Oil Co.	24.25.02.142	4042	400	3642	TC	WR
Robb Spring 1			1000	3042	TC	WR
Amoco Prod. Co.	24.25.06.243	3894.2	1680	2214	PZ	CNL
State IX Com 1			1950	1944	PZ	CNL
			2100	1794	PZ	CNL
			2420	1474	PZ	CNL
			2530	1364	PZ	CNL
Amoco Prod. Co.	24.25.06.310	3825.7	1450	2376	PZ	CNL
HK Com 1			1920	1906	PZ	CNL
			2150	1676	PZ	CNL
HNG Oil Co.	24.25.10.123	4039	1350	2689	PZ	SL
Horseshoe Bend 10 Com 1			1970	2069	PZ	SL
			2200	1839	PZ	SL
			2420	1619	PZ	SL
			2510	1529	PZ	SL
			2650	1389	PZ	SL
David Fasken	24.25.18.134	4359.8	998	3362	LC	WR
Maralo State Com 1-Y						
David Fasken	24.25.18.134a	4359.8	1015	3345	LC	WR
Maralo State Com 1						
Chaparral Prod.	24.25.24.234	3856	481	3375	CA	WR
Wood Canyon 1-Y			837	3019	LC	WR
Superior Oil Co.	24.25.25.143	3578	680	2898	PZ	SL
Caverns Fed. Com 1						
C & K Pet. Inc.	24.26.17.142	3491.5	727	2765	LC	WR
Exxon Fed. Com 1			750	2742	TC	WR
C & K Pet. Inc.	24.26.17.414	3435	620	2815	PZ	SL
Exxon Fed. Com 2			1070	2365	PZ	SL
			1210	2225	PZ	SL
Gulf Oil Corp.	24.26.20.233	3379	1160	2219	PZ	SL
Estill AD Fed. 2						

APPENDIX G

DIAMONDBACK FEDERAL NO. 1 WELL APPLICATIONS AND SURFACE OWNER AGREEMENTS

1. Application For Permit to Drill (APD)
2. Road Right-of-Way Application
3. Surface Owner Agreement

Form 3160-3
(November 1983)
(formerly 9-331C)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

SUBMIT IN TRIPLICATE*
(Other instructions on reverse side)

Form approved.
Budget Bureau No. 1004-0136
Expires August 31, 1985

APPLICATION FOR PERMIT TO DRILL, DEEPEN, OR PLUG BACK

5. LEASE DESIGNATION AND SERIAL NO. NM-62161

6. IF INDIAN, ALLOTTEE OR TRIBE NAME

7. UNIT AGREEMENT NAME

8. FARM OR LEASE NAME Diamondback Federal

9. WELL NO. 1

10. FIELD AND POOL, OR WILDCAT Wildcat

11. SEC., T., R., M., OR BLK. AND SURVEY OR AREA Section 19-24S-24E

12. COUNTY OR PARISH Eddy

13. STATE NM

1a. TYPE OF WORK
DRILL ☒ DEEPEN ☐ PLUG BACK ☐

b. TYPE OF WELL
OIL WELL ☐ GAS WELL ☒ OTHER SINGLE ZONE ☒ MULTIPLE ZONE ☐

2. NAME OF OPERATOR
Yates Energy Corporation

3. ADDRESS OF OPERATOR
P. O. Box 2323, Roswell, New Mexico 88202-2323

4. LOCATION OF WELL (Report location clearly and in accordance with any State requirements.*)
At surface 2007' FSL & 1063' FEL
At proposed prod. zone

14. DISTANCE IN MILES AND DIRECTION FROM NEAREST TOWN OR POST OFFICE*
27 miles S.W. of Carlsbad, New Mexico

15. DISTANCE FROM PROPOSED* LOCATION TO NEAREST PROPERTY OR LEASE LINE, FT. (Also to nearest drlg. unit line, if any) 1063'

16. NO. OF ACRES IN LEASE 1281.68

17. NO. OF ACRES ASSIGNED TO THIS WELL 320

18. DISTANCE FROM PROPOSED LOCATION* TO NEAREST WELL, DRILLING, COMPLETED, OR APPLIED FOR, ON THIS LEASE, FT. none

19. PROPOSED DEPTH 10,500'

20. ROTARY OR CABLE TOOLS Rotary

21. ELEVATIONS (Show whether DF, RT, GR, etc.)
4316.3 GR

22. APPROX. DATE WORK WILL START* 7-1-91

23.
PROPOSED CASING AND CEMENTING PROGRAM

SIZE OF HOLE	SIZE OF CASING	WEIGHT PER FOOT	SETTING DEPTH	QUANTITY OF CEMENT
17 1/2"	13 3/8"	48# - 54#	350'	350 sx. circulate
12 1/4"	8 5/8"	24# - 32#	2,600'	1100 sx. circulate
7 7/8"	4 1/2" - 5 1/2"	11.6# -17#	TD	450 sx.

Yates Energy Corporation proposes to drill and test the Morrow and intermediate formations. Approximately 350' of surface casing and 2600' of intermediate casing will be set and cemented to the surface. If commercial pay is encountered, will run either 4 1/2" or 5 1/2" casing and cement with a minimum of 600' of space cover; perforate and stimulate as needed for production.

BOP PROGRAM: BOP and Hydrill on 8 5/8" casing, pipe rams tested daily, and blind rams tested on trips.

GAS IS NOT DEDICATED

IN ABOVE SPACE DESCRIBE PROPOSED PROGRAM: If proposal is to deepen or plug back, give data on present productive zone and proposed new productive zone. If proposal is to drill or deepen directionally, give pertinent data on subsurface locations and measured and true vertical depths. Give blowout preventer program, if any.

24.
SIGNED Sharon R. Hamilton TITLE Landman DATE 1-28-91

(This space for Federal or State office use)

PERMIT NO. ______ APPROVAL DATE ______

APPROVED BY ______ TITLE ______ DATE ______
CONDITIONS OF APPROVAL, IF ANY:

*See Instructions On Reverse Side

Title 18 U.S.C. Section 1001, makes it a crime for any person knowingly and willfully to make to any department or agency of the United States any false, fictitious or fraudulent statements or representations as to any matter within its jurisdiction.

4. LOCATION OF EXISTING AND/OR PROPOSED FACILITIES

A. There are no production facilities on this lease at this time.

B. If the well proves to be commercial, the necessary production facilities will be installed on the drilling pad.

5. LOCATION AND TYPE OF WATER SUPPLY

A. It is planned to drill this well with fresh and/or brine water. The water will be obtained from commercial sources and trucked to the location via the proposed route.

6. SOURCES OF CONSTRUCTION MATERIALS

A. Caliche, if possible, for surfacing the road and the well pad will be taken from the pad area.

7. METHODS OF HANDLING WASTE DISPOSAL

A. Drill cuttings will be disposed in the reserve pits.

B. Drilling fluids will be allowed to evaporate in the reserve pits until dry.

C. All pits will be fenced with normal fencing materials to prevent livestock from entering the area only if cattle are run in this pasture.

D. Water produced during operations will be collected in tanks until hauled to an approved disposal system, or a separate disposal application will be submitted to BLM for approval.

E. Current laws and regulations pertaining to the disposal of human waste will be complied with.

F. Oil produced during operations will be stored in tanks until sold.

G. Trash, waste paper, garbage and junk will be buried in a separate trash pit and covered with minimum of 24 inches of dirt. All waste material will be contained to prevent scattering by the wind.

8. ANCILLARY FACILITIES

A. None required.

9. WELLSITE LAYOUT

A. The well pad exhibit shows the relative location and dimensions of the well pad and reserve pits, etc.

B. The location surface is relatively flat.

C. Caliche for the road and pad will be hauled from the nearest pit.

D. The reserve pits will be to the north and lined.

E. A 400' x 400' area has been staked and flagged.

10. PLANS FOR RESTORATION OF THE SURFACE

A. After finishing drilling and/or completion operations all equipment and other material not needed for further work will be removed. The location will be cleaned of all trash and junk leaving the wellsite in as aesthetically pleasing a condition as possible.

B. If the pits were fenced, they will remain so until they have dried and are leveled.

C. If this well is non-productive, all rehabilitation and/or vegetation requirement of the Landowner/Operator agreement, if any, will be complied with and accomplished as expeditiously as possible. All pits will be filled and leveled within 90 days after abandonment or are no longer needed.

11. OTHER INFORMATION

A. Topography: The location is relatively flat. The existing road is on flat surface to the location.

B. Soil: The topsoil is a thin layer and may not be adequate to stockpile.

C. Flora and Fauna: Vegetative cover consist of various grasses, mesquite, Lachugilla, and other miscellaneous growth. No wildlife was observed, but the wildlife in the area probably includes those typical of semi-arid desert land.

D. Land use: Cattle grazing.

E. There are no dwellings in the vicinity of the wellsite.

F. Surface Ownership: The pad and road are on private land with federal minerals.

Owner: Bill Hoyle, P. O. Box 106, Pearsall, TX 78061. Yates Energy Corporation has negotiated and Agreement with said owner for use of their surface for drilling purposes and right-of-way access.

Submit to Appropriate
District Office
State Lease - 4 copies
Fee Lease - 3 copies

DISTRICT I
P.O. Box 1980, Hobbs, NM 88240

DISTRICT II
Drawer DD, Artesia, NM 88210

DISTRICT III
1000 Rio Brazos Rd., Aztec, NM 87410

State of New Mexico
Energy, Minerals and Natural Resources Department

Form C-102
Revised 1-1-89

OIL CONSERVATION DIVISION

P.O. Box 2088
Santa Fe, New Mexico 87504-2088

WELL LOCATION AND ACREAGE DEDICATION PLAT

All Distances must be from the outer boundaries of the section

Operator YATES ENERGY CORP.			Lease Diamondback Federal		Well No. 1
Unit Letter I	Section 19	Township 24 SOUTH	Range 24 EAST NMPM	County EDDY	

Actual Footage Location of Well:
2007 feet from the SOUTH line and 1063 feet from the EAST line

Ground level Elev. 4316.3	Producing Formation Morrow	Pool Wildcat	Dedicated Acreage: 320 Acres

1. Outline the acreage dedicated to the subject well by colored pencil or hachure marks on the plat below.

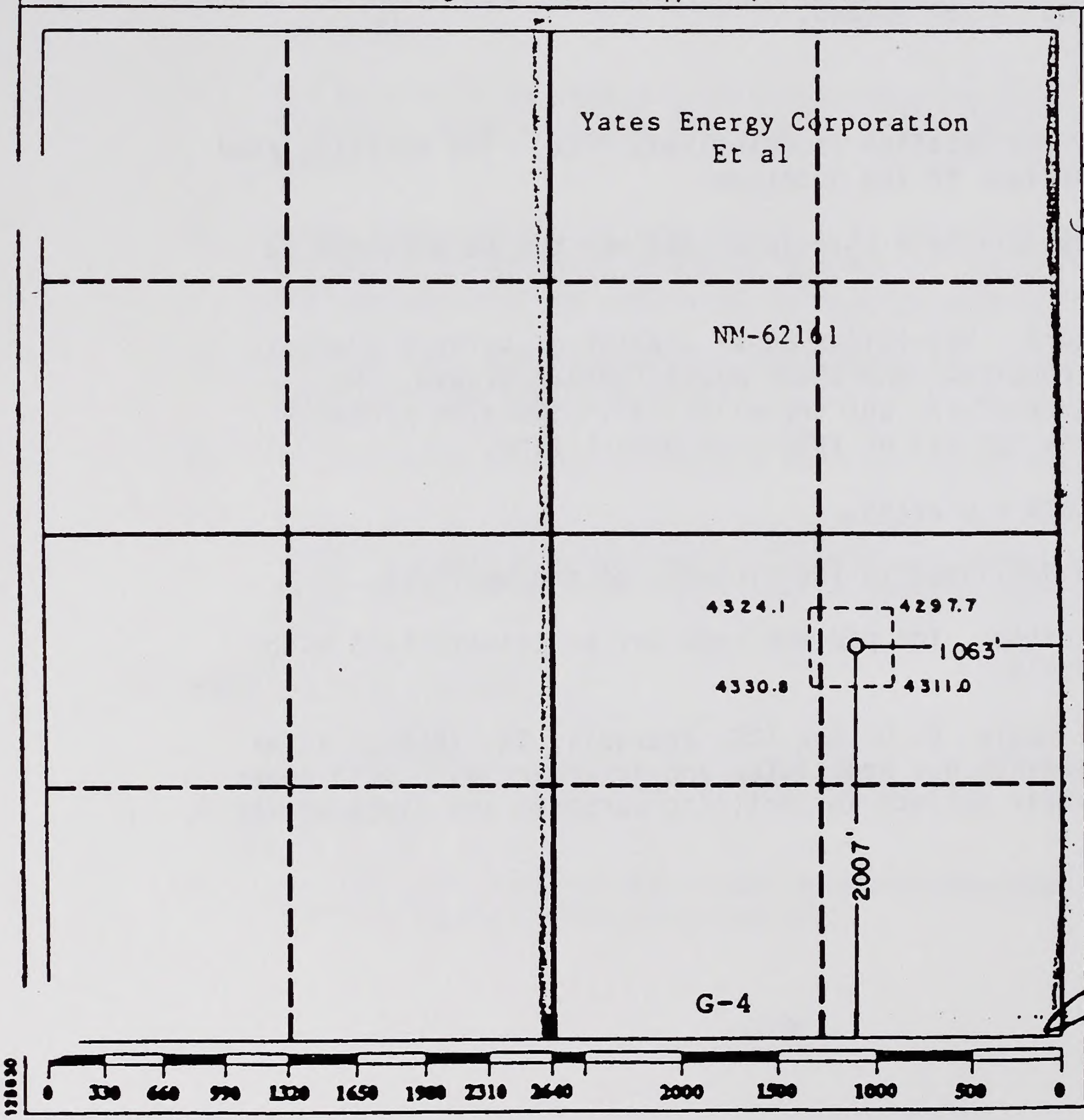
2. If more than one lease is dedicated to the well, outline each and identify the ownership thereof (both as to working interest and royalty).

3. If more than one lease of different ownership is dedicated to the well, have the interest of all owners been consolidated by communitization, unitization, force-pooling, etc.?

☐ Yes ☐ No If answer is "yes" type of consolidation ______

If answer is "no" list the owners and tract descriptions which have actually been consolidated. (Use reverse side of this form if neccessary. ______

No allowable will be assigned to the well until all interests have been consolidated (by communitization, unitization, forced-pooling, or otherwise) or until a non-standard unit, eliminating such interest, has been approved by the Division.



OPERATOR CERTIFICATION

I hereby certify that the information contained herein in true and complete to the best of my knowledge and belief.

Signature
Sharon R. Hamilton

Printed Name
Sharon R. Hamilton

Position
Landman

Company
Yates Energy Corporation

Date
1-28-91

SURVEYOR CERTIFICATION

I hereby certify that the well location shown on this plat was plotted from field notes of actual surveys made by me or under my supervision, and that the same is true and correct to the best of my knowledge and belief.

Date Surveyed
1-10-91

Signature & Seal of Professional Surveyor

Certificate No. JOHN W. WEST	676
RONALD J. EIDSON	3239

YATES ENERGY CORPORATION
Diamondback Federal #1
2007' FSL & 1063' FEL
Section 19, T24S, R24E
Eddy County, New Mexico

In conjunction with Form 9-331-C, Application for Permit to Drill the well captioned above, Yates Energy Corporation submits the following ten items of pertinent information in accordance with BLM requirements.

1. The geologic surface formation is the Grayburg.

2. The estimated tops of geologic markers are as follows:

Base of Capitan Reef	2285'	Morrow Oalite	9925'
Delaware Pay Sands	2887'	Morrow Sands	9960'
Bone Springs	3337'	Lower Morrow	10,162'
Wolfcamp	7732'	Barnett	10,400'
Strawn	9020'	TD	10,450'
Atoka	9120'		

3. The estimated depths at which anticipated water, oil, or gas formations are expected to be encountered:

   Water: Fresh water at approximately 150'
   Oil or Gas: Delaware 2887', Bone Springs Carbonate 5300', Canyon 8900', Strawn 9020', Morrow Clastics 9960'

4. Proposed Casing Program: See Form 9-331-C

5. Pressure Control Equipment: See Form 9-331-C and Exhibit.

6. Mud Program:

Mud Program:	0 - 350'	FW Spud,
	350' - 2400'	FW, Cut brine, 8.4#/gal.
	2400' - 9000'	Cut brine, 8.4-9.0#/gal., Vis. 28-30
	9000' - TD	Cut brine, 9.0-9.3#/gal., Vis. 30-50, W.L. 6-10

7. Auxiliary Equipment: Kelly Cock; pit level indicators and flow sensor equipment; full-opening safety valve on floor with drill pipe and collar connections.

8. Testing, Logging and Coring Program:

DST's:	If Warranted
Coring:	None planned
Logging:	Intermediate to TD CNL-LDT to casing with GR-CNL on to surface and DLL from TD to casing with selected RxO.

9. No abnormal pressures or temperatures are anticipated. In the event they are encountered, the proposed mud program will be modified to increase the mud weight.

10. Anticipated starting date: Around July 1, 1991. Drilling time will be approximately 35 days.

12. OPERATOR'S REPRESENTATIVE

A. The field representative responsible for assuring compliance with the approved surface use and operations plan is:

Jim O'Briant
O'Briant Engineering
Midland, Texas
Phone: 915-683-5511

13. CERTIFICATION

I hereby certify that I, or persons under my direct supervision, have inspected the proposed drillsite and access route, that I am familiar with the conditions which presently exist; that the statements made in this plan are to the best of my knowledge, true and correct; and, that the work associated with the operations proposed herein will be performed by Yates Energy Corporation and its contractors and subcontractors in conformity with this plan and the terms and conditions under which it is approved.

Sharon R. Hamilton

January 28, 1991
Date

Sharon R. Hamilton, Landman for
Yates Energy Corporation

MULTI-POINT SURFACE USE AND OPERATIONS PLAN

Yates Energy Corporation
Diamondback Federal #1
2007' FSL & 1063' FEL
Section 19, T24S, R24E
Eddy County, New Mexico

This plan is submitted with Form 9-331-C, Application for Permit to Drill, covering the above described well. The purpose of this plan is to describe the location of the proposed well, the proposed construction activities and operations plan, the magnitude of surface disturbance involved and the procedures to be followed in rehabilitating the surface after completion of the operations, so that a complete appraisal can be made of the environmental effect associated with the operations.

1. EXISTING ROADS

Exhibit B is a portion of a BLM topographic map showing the roads in the vicinity of the proposed location. The proposed well site is approximately 27 miles southwest of Carlsbad. The access route is indicated in green for BLM Right-of-Way, blue for State Right-of-Way, yellow for fee Right-of-Way on Exhibit B. The new access road is indicated in pink on Exhibit A.

Directions:

1. Travel from Carlsbad on US 62/180 (El Paso Highway).
2. 1 mile past Port-of-Entry turn west onto County Road #408 (Dark Canyon Highway), go approx. 20 miles.
3. Turn South onto dirt road (Lechuguilla Canyon Road), Chevron lease sign at turn.
4. Go approx. 7 1/2 miles.
5. Turn west, the new access road to the wellsite will go approx. 1000' (marked on Exhibit A in pink).

2. PLANNED ACCESS ROAD

A. The proposed new road will be approximately 1000' in length to the west from the existing road.

B. The new road will have a 12 foot driving surface.

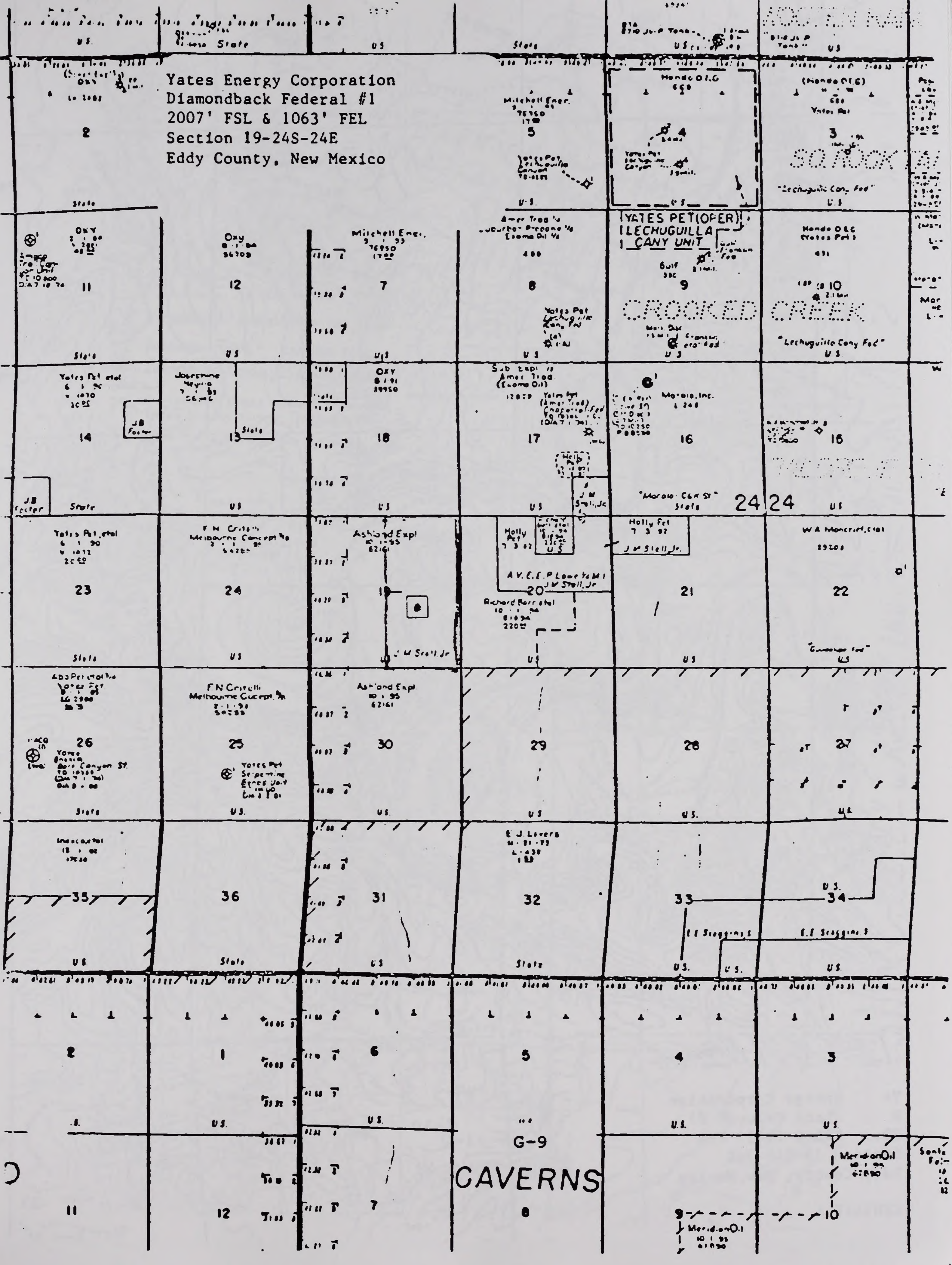
C. The new road will be bladed with drainage on one side and surfaced where needed.

D. The route of the road is staked.

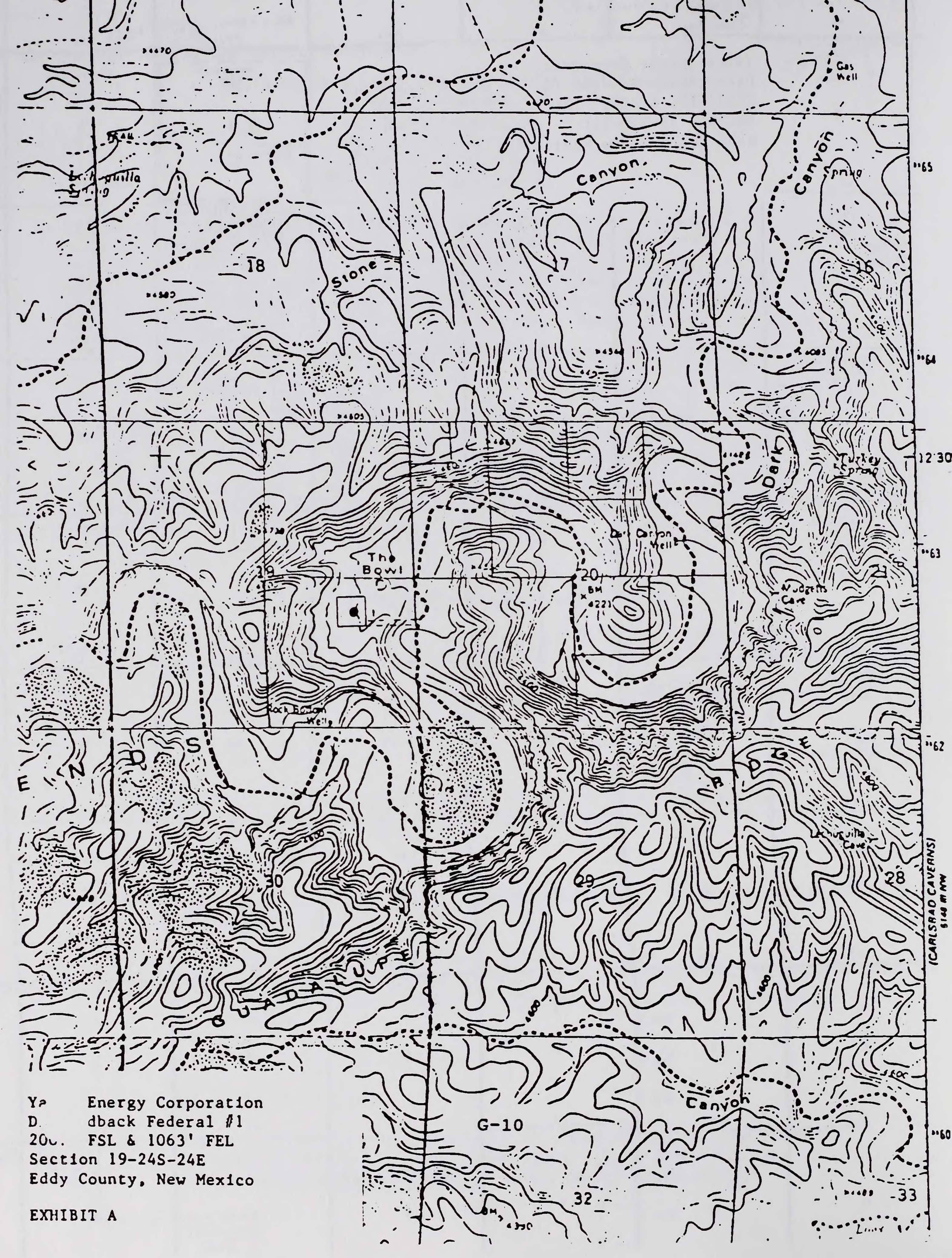
3. LOCATION OF EXISTING WELLS

A. Temporarily Abandoned - Sidewinder #1, located approx. 3/4 mile northeast of the proposed location (2310' FNL & 1980' FWL in Section 20-24S-24E), operated by Yates Energy Corporation.

Yates Energy Corporation
Diamondback Federal #1
2007' FSL & 1063' FEL
Section 19-24S-24E
Eddy County, New Mexico

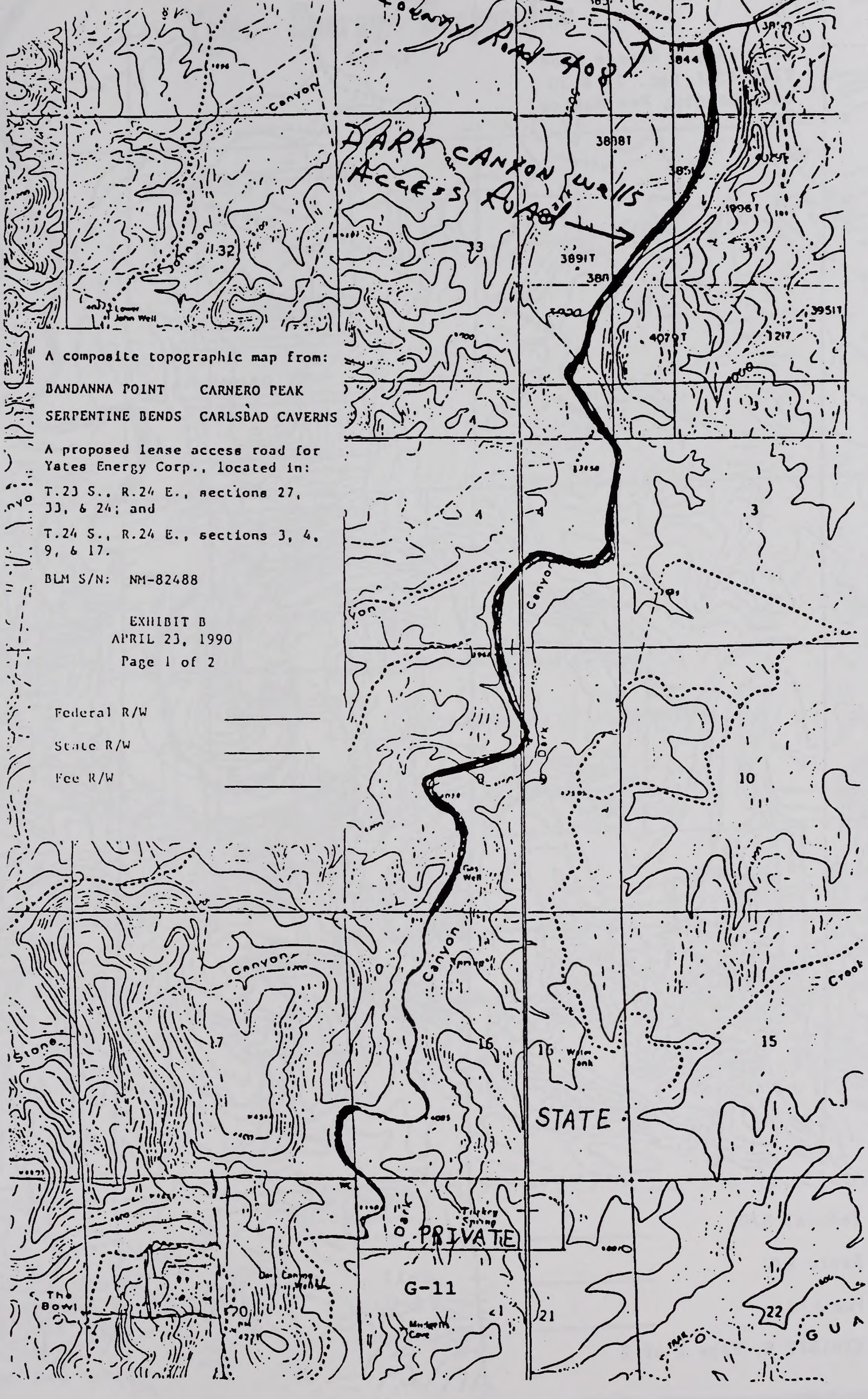


G-9



Ya Energy Corporation
D. dback Federal #1
20. FSL & 1063' FEL
Section 19-24S-24E
Eddy County, New Mexico

EXHIBIT A



A composite topographic map from:

BANDANNA POINT CARNERO PEAK
SERPENTINE BENDS CARLSBAD CAVERNS

A proposed lease access road for Yates Energy Corp., located in:

T.23 S., R.24 E., sections 27, 33, & 24; and

T.24 S., R.24 E., sections 3, 4, 9, & 17.

BLM S/N: NM-82488

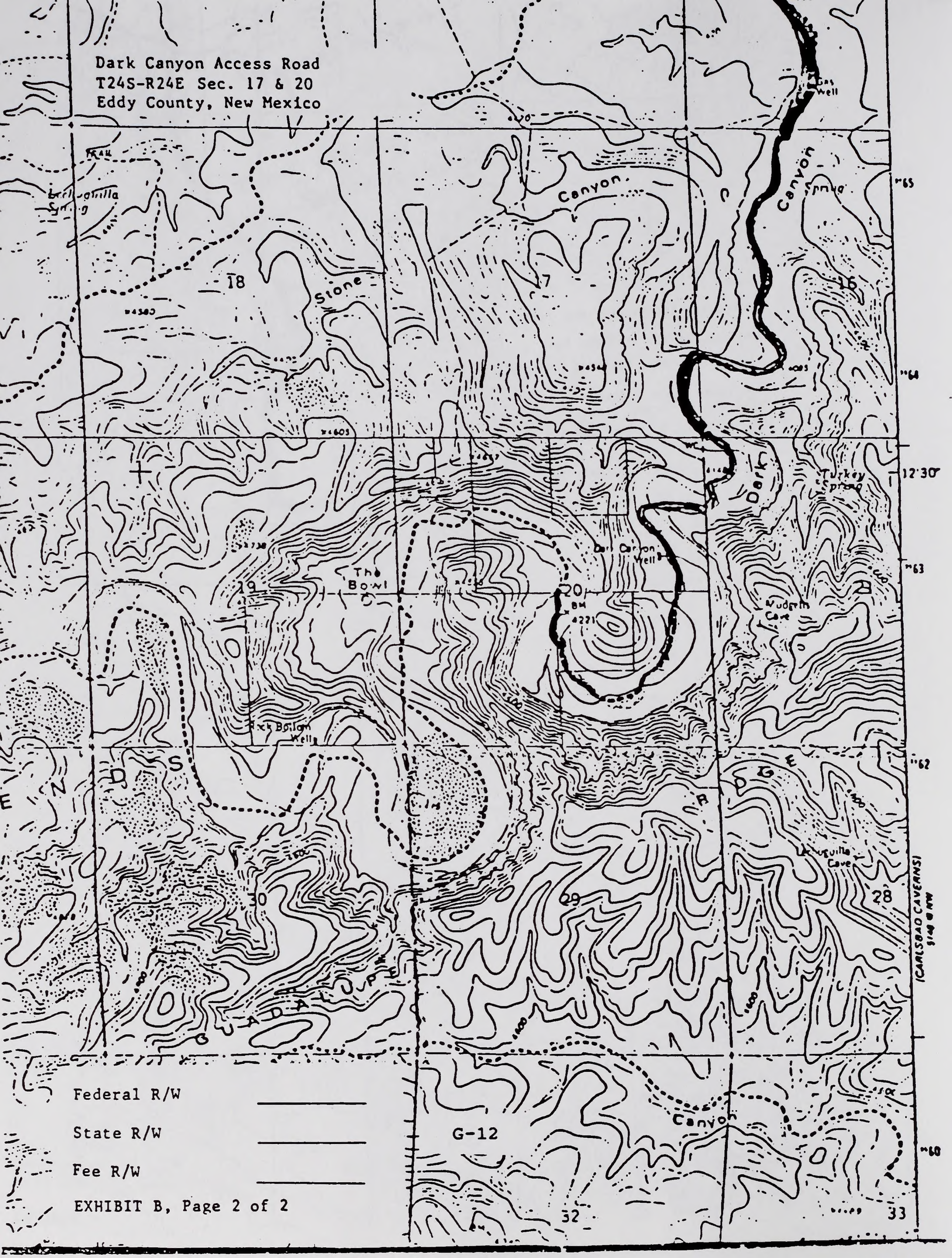
EXHIBIT B
APRIL 23, 1990
Page 1 of 2

Federal R/W ____________

State R/W ____________

Fee R/W ____________

Dark Canyon Access Road
T24S-R24E Sec. 17 & 20
Eddy County, New Mexico



Federal R/W ____________

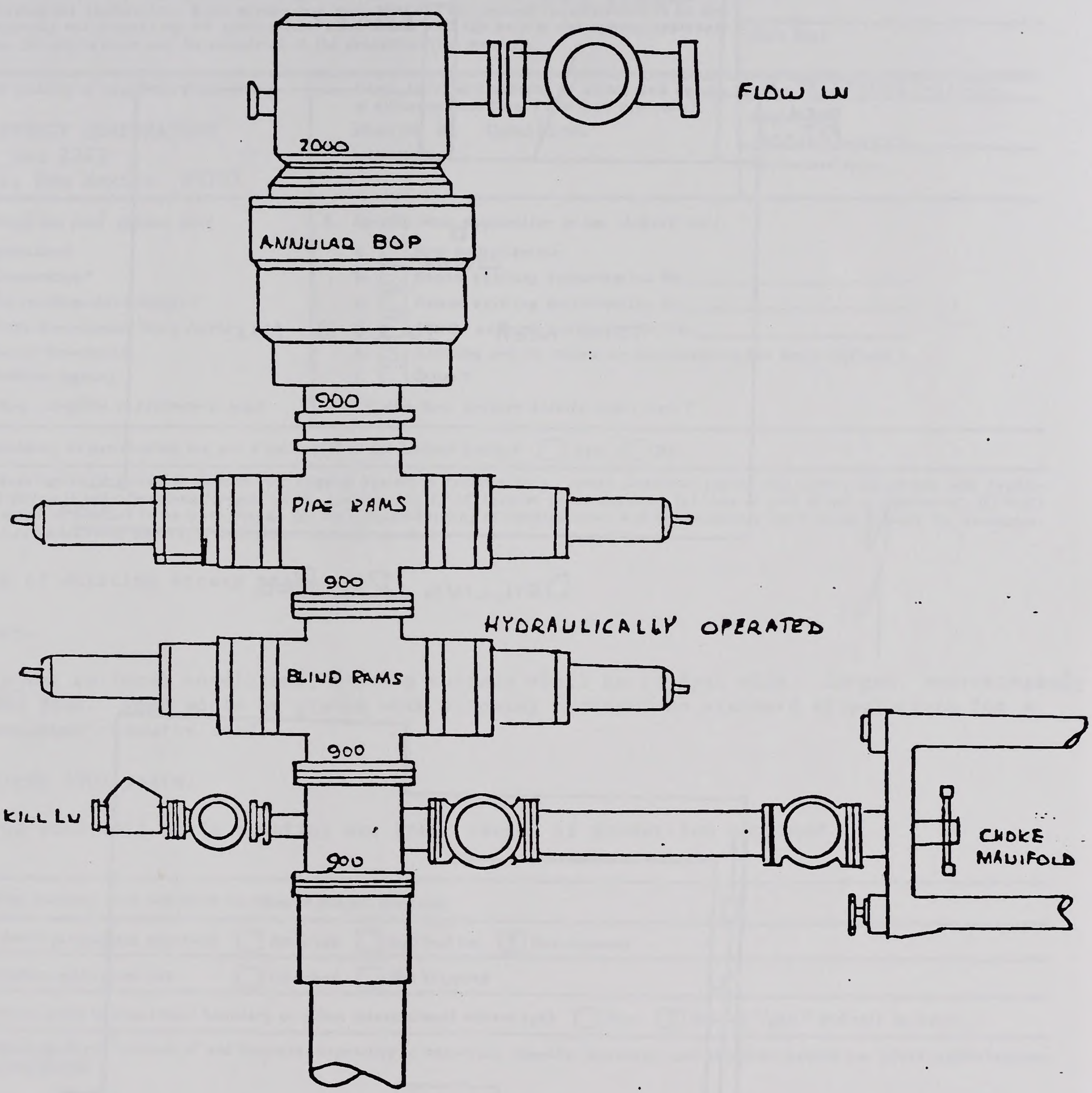
State R/W ____________

Fee R/W ____________

EXHIBIT B, Page 2 of 2

Yates Energy Corporation

Exhibit

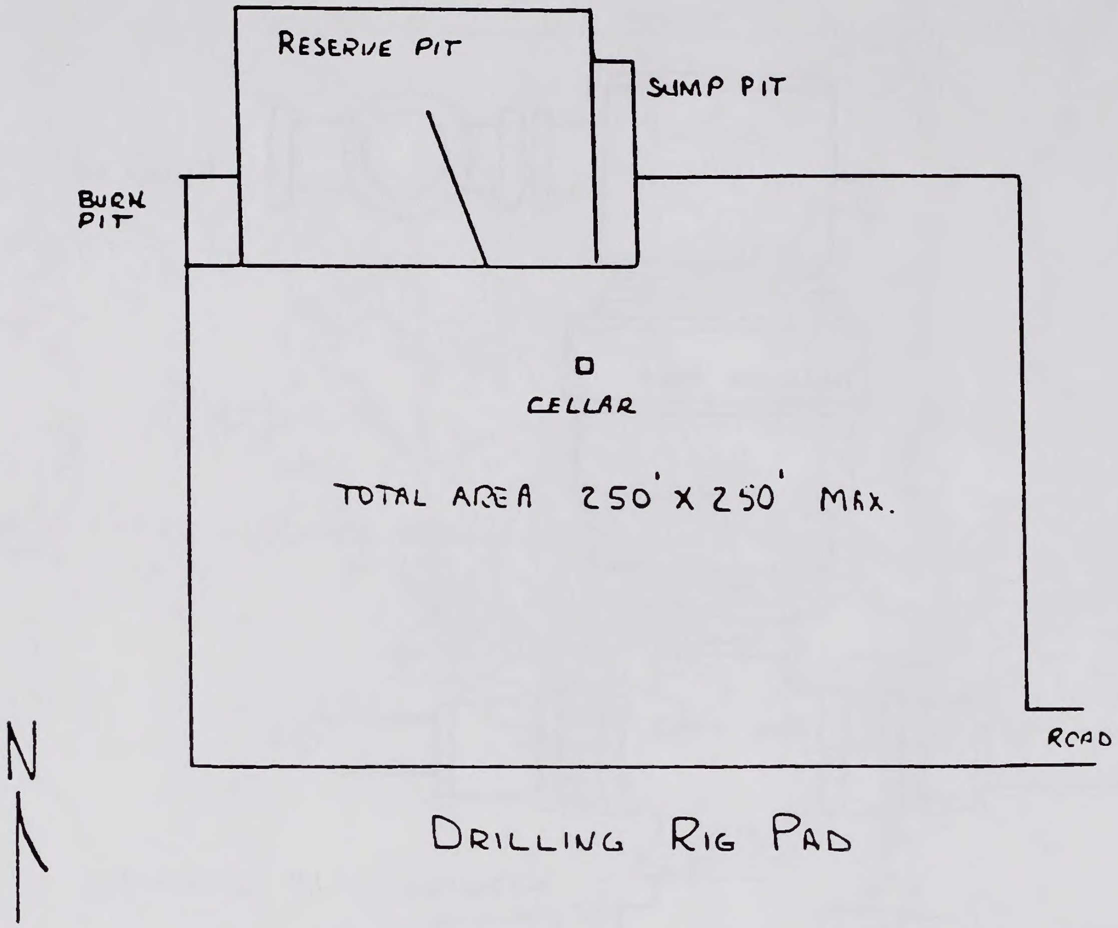


BOP

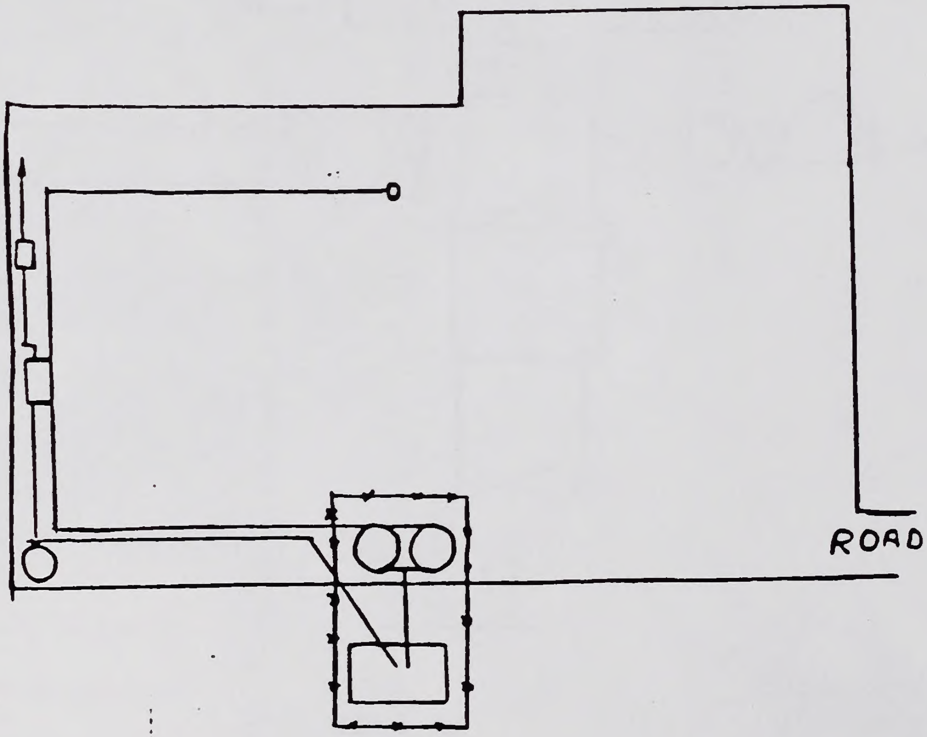
s Energy Coporation
ondback Federal #1
2007' FSL & 1063' FEL
Section 19-24S-24E
Eddy County, New Mexico

Yates Energy Corporation

Exhibit



DRILLING RIG PAD



s Energy Corporation
ondback Federal #1
2007' FSL & 1063' FEL
Section 19-24S-24E
Eddy County, New Mexico

TANK BATTERY · LAYOUT

G-14

STANDARD FORM 299 (10-87)
Prescribed by DOI/USDA/DOT
P.L. 96-487 and Federal
Register Notice 6-3-81

APPLICATION FOR TRANSPORTATION AND UTILITY SYSTEMS AND FACILITIES ON FEDERAL LANDS

RECEIVED
JUL 11 11 31 AM '91

FORM APPROVED
OMB NO. 1004-0060
Expires: May 31, 1989

Before completing and filing the application, the applicant should completely review this package and schedule a preapplication meeting with representatives of the agency responsible for processing the application. Each agency may have specific and unique requirements to be met in preparing and processing the application. Many times, with the help of the agency representative, the application can be completed at the preapplication meeting.

FOR AGENCY USE ONLY

Application Number

Date filed

1. Name and address of applicant *(include zip code)*

YATES ENERGY CORPORATION
P. O. Box 2323
Roswell, New Mexico 88202

2. Name, title, and address of authorized agent if different from Item 1 *(include zip code)*

Sharon R. Hamilton
Landman

3. TELEPHONE *(area code)*

Applicant
505/623-4935

Authorized Agent

4. As applicant are you? *(check one)*

- a. ☐ Individual
- b. ☒ Corporation*
- c. ☐ Partnership/Association*
- d. ☐ State Government/State Agency
- e. ☐ Local Government
- f. ☐ Federal Agency

* *If checked, complete supplemental page*

5. Specify what application is for: *(check one)*

- a. ☐ New authorization
- b. ☐ Renew existing authorization No. ____________
- c. ☐ Amend existing authorization No. ____________
- d. ☐ Assign existing authorization No. ____________
- e. ☒ Existing use for which no authorization has been received*
- f. ☐ Other*

* *If checked, provide details under Item 7*

6. If an individual, or partnership are you a citizen(s) of the United States? ☐ Yes ☐ No

7. Project description *(describe in detail)*: (a) Type of system or facility, *(e.g., canal, pipeline, road)*, (b) related structures and facilities; (c) physical specifications *(length, width, grading, etc.)*; (d) term of years needed; (e) time of year of use or operation, (f) Volume or amount of product to be transported; (g) duration and timing of construction, and (h) temporary work areas needed for construction. *(Attach additional sheets, if additional space is needed.)*

Use of existing access road.

B. None.

C. Subject to local conditions, driving surface shall be 14 feet wide. Length, approximately 2300 feet. Road would be grated with ditching pursuant to standard stipulations for a permanent resource road.

D. Thirty (30) years.

E. This road will be in constant use (year round) if production obtained.

8. Attach map covering area and show location of project proposal

9. State or local government approval: ☐ Attached ☐ Applied for ☒ Not required

10. Nonreturnable application fee: ☐ Attached ☐ Not required

11. Does project cross international boundary or affect international waterways? ☐ Yes ☒ No *(If "yes," indicate on map)*

12. Give statement of your technical and financial capability to construct, operate, maintain, and terminate system for which authorization is being requested.

Yates Energy Corporation operates gas pipelines in Eddy County, New Mexico under R-O-W NM-77925 (OG) and operates numerous oil and gas wells in Southeastern New Mexico.

(Continued on reverse)

7. PROJECT DESCRIPTION
Continued

F. Traffic restricted to vehicles necessary for drilling and completing a oil/and or gas well. Then minimum traffic for well maintenance.

G. Construction would commence at some future date after approval, to be completed in approximately 1 day.

H. A temporary work area will not be required for this project.

13a. Describe other reasonable alternative routes and modes considered.

Possible construction across fee surface lands adjacent to federal surface lands.

Why were these alternatives not selected?

Would cause unnecessary damage in scenic area, cost would be beyond economic levels.

c. Give explanation as to why it is necessary to cross Federal lands.

To access federal oil/gas lease NM-62121 for puposes of drilling an exploratory well in Section 19-24S-24E.

14. List authorizations and pending applications filed for similar projects which may provide information to the authorizing agency. *(Specify number, date, code, or name.)*

Off lease access road R-O-W NM-82213 (NE) dated 1-2-90, Dark Canyon Access R-O-W NM-82488 (NE).

15. Provide statement of need for project, including the economic feasibility and items such as: (a) cost of proposal *(construction, operation, and maintenance)*; (b) estimated cost of next best alternative; and (c) expected public benefits.

A. Cost would be minimal, construction limited to blading existing road only if necessary. The road would be maintained pursuant to standard stipulations and usage.
B. None.
C. Public benefit would be potential production of oil and/or gas minerals.

Describe probable effects on the population in the area, including the social and economic aspects, and the rural lifestyles.

The proposed project is located in an uninhabitated area, upon completion of drilling activities if production is obtained, traffic associated with operation and maintenance would be minimal. There should be no effect on rural lifestyles.

17. Describe likely environmental effects that the proposed project will have on: (a) air quality; (b) visual impact; (c) surface and ground water quality and quantity; (d) the control or structural change on any stream or other body of water; (e) existing noise levels; and (f) the surface of the land, including vegetation, permafrost, soil, and soil stability.

A. Increase in dust when in use.
B. Existing road - minimal.
C. None.
D. None.
E. Only when in use.
F. None - existing road.

18. Describe the probable effects that the proposed project will have on: (a) populations of fish, plant, wildlife, and marine life, including threatened and endangered species; and (b) marine mammals, including hunting, capturing, collecting, or killing these animals.

A. Possible disturbance during drilling activities, otherwise minimal effect.

B. None.

19. Name all the Department(s)/Agency(ies) where this application is being filed.

Bureau of Land Management
P. O. Box 1778
Carlsbad, New Mexico 88220

I HEREBY CERTIFY, That I am of legal age and authorized to do business in the State and that I have personally examined the information contained in the application and believe that the information submitted is correct to the best of my knowledge.

ture of Applicant Sharon R. Hamilton	Date July 10, 1991

Title 18, U.S.C. Section 1001, makes it a crime for any person knowingly and willfully to make to any department or agency of the United States any false, fictitious, or fraudulent statements or representations as to any matter within its jurisdiction.

RECEIVED

JUL 9 10 52 AM '91

CAR [illegible]
AREA [illegible]

yates energy corporation

January 16, 1991

Bill Hoyle
P. O. Box 106
Pearsall, Texas 78061

Re: Dark Canyon Area
Eddy County, NM

Dear Mr. Hoyle:

Please be advised that we have staked a well location as follows:

2007' FSL & 1063' FEL
Section 19-24S-24E

The proposed access road will go from the Southeast corner of the drilling pad straight east to the existing road. Said road has been staked, per the attached topo map.

Please indicate below your approval of said proposed access route by executing in the space provided below, returning one form of this letter to our office at your earliest convenience.

Yours very truly,

YATES ENERGY CORPORATION

Sharon R. Hamilton

Sharon R. Hamilton
Landman

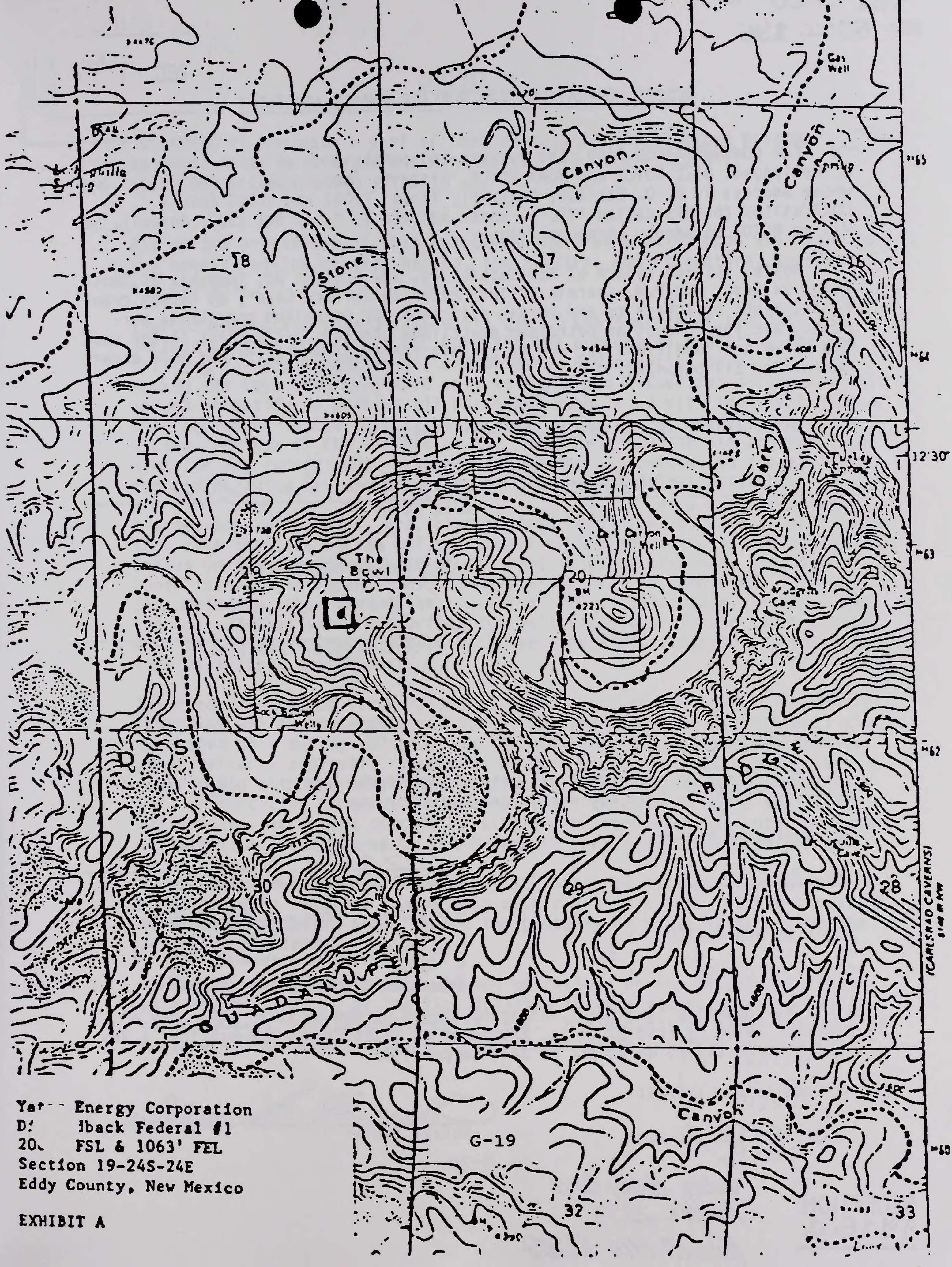
Approved this 22 day of January, 1991.

Bill Hoyle

Bill Hoyle

SRH/jj

P.O. Box 2323, Sunwest Centre, Suite 1010, Roswell, New Mexico 88202 (505) 623-4935 · Fax (505) 623-4947



Ya- Energy Corporation
D- lback Federal #1
20- FSL & 1063' FEL
Section 19-24S-24E
Eddy County, New Mexico

EXHIBIT A

G-19

DEC 17 '90

ACCESS, OPERATIONS AND SURFACE DAMAGE AGREEMENT

FOR CONSIDERATION PAID, the receipt and sufficiency of which is hereby acknowledged, BILL HOYLE and MONA HOYLE, his wife (herein called "HOYLE"), whose address is P. O. Box 106, Pearsall, Texas 78061 and YATES ENERGY CORPORATION (herein called "YEC"), whose address is P. O. Box 2323, Roswell, New Mexico 88202 do hereby agree as follows:

Hoyle, surface owners of SE¼ Section 19, SW¼ Section 20, Township 24 South, Range 24 East, N.M.P.M. (herein called "Patented Surface Land") do hereby grant to YEC right of access to and across said land for petroleum operations purposes, and for conduct of petroleum operations thereon, but subject to and upon the terms and conditions set out on Exhibit "A" attached hereto and made a part hereof for all purposes.

DATED this 13th day of November, 1990.

Mona Hoyle
MONA HOYLE, his wife

Bill Hoyle
BILL HOYLE

YATES ENERGY CORPORATION

By: Fred G. Yates
Fred G. Yates, President

STATE OF TEXAS)
) ss.
COUNTY OF Frio)

The foregoing instrument was acknowledged before me this 13th day of November, 1990, by Bill Hoyle and Mona Hoyle, his wife.

My Commission Expires:
6-30-92

Thelma Burris
Notary Public

THELMA BURRIS
Notary Public
State of Texas
My commission expires 06-30-92

STATE OF NEW MEXICO)
) ss.
COUNTY OF CHAVES)

The foregoing instrument was acknowledged before me this 19th day of November 1990, by Fred G. Yates, President of Yates Energy Corporation, a New Mexico Corporation, on behalf of said corporation.

My Commission Expires:
2-30-92

Sharon B. Hamilton
Notary Public

G-20

RECEPTION
91631

Yates Energy Corp
PO Box 2323
Roswell NM 88202

EXHIBIT "A"

To be attached to and made a part of that certain Agreement dated November 13th, 1990 by and between Bill Hoyle and Mona Hoyle, his wife ("Hoyle"), and Yates Energy Corporation ("YEC").

1. All of the provisions of this agreement shall be binding upon and inure to the benefit of the parties hereto, their heirs, administrators, successors and assigns.

2. Ingress and egress to and reasonable use of the surface of the Patented Surface Land is granted to YEC only for the purpose of exploring for and drilling for and producing oil and/or gas. Any exterior gates shall be locked and keys made available only to Hoyle and authorized personnel. YEC agrees to notify in writing all personnel associated with implementation of this agreement in the capacity of drilling, exploring, producing or servicing that use of the surface of the lands described herein are not to be used for any recreational or other activities not related to the exploring for and drilling for and producing of oil and/or natural gas.

3. Any debris, rocks, dirt, etc. cleared from road right of ways or well location site shall be hauled off and dumped in the nearest crossing of Dark Canyon on the downstream side of the road or to an area more practical in consultation with Hoyle within 60 days after well is completed, unless circumstances arise beyond the control of YEC to delay said cleanup. Any top soil cleared from the surface for well locations or road right-of-ways will be stockpiled to be spread back over the surface during any restoration of surface operations.

4. Any road constructed for purposes of ingress and egress to drilling and/or producing wells should be a maximum of 25 feet wide unless additional width is needed only during construction thereof. Hoyle is to be contacted for width variance approval. Should it be determined that YEC's authorized traffic did not stay within the confines of the right-of-way, restoration will be conducted to correct any damage. If necessary, Hoyle and YEC to reach mutual agreement concerning single-lane road with turnouts, pursuant to guidelines established by the Bureau of Land Management road policy.

   All roads used and/or constructed by YEC shall be maintained with routine maintenance as required to maintain such roads in a safe, usable condition. Any road constructed shall become the property of Hoyle at such time the agreement terminates.

5. YEC shall consult Hoyle prior to any operations on the Patented Surface Land for the purpose of locating drilling surface sites, roads, pipeline right of ways, cattleguards, gates, etc. Hoyle shall be given the name of persons and telephone numbers of YEC personnel for contact purposes.

Exhibit "A"
Page 2

6. YEC shall pay Hoyle $3,000 for each well drilled on the Patented Surface Land for normal foreseeable damages to the surface caused by building on the location, and $4.00 per rod for any new road construction. In addition, YEC shall pay Hoyle the actual amount of any loss of livestock or damage to personal property caused by YEC's operations on the Patented Surface Land.

7. YEC agrees to pay Hoyle an annual rental for road right-of-way as follows:

   A. For access into Section 19, T-24-S, R-24-E, an annual rental of $400.00, to commence if and when YEC spuds a well in said section and shall continue so long as said well or wells are producing.

   B. For access into Section 30, T-24-S, R-24-E, an annual rental of $360.00 for each producing well located in said Section 30. Payment to commence if and when YEC spuds a well in said section and shall continue so long as said well or wells are producing.

8. YEC agrees to reclamate any location on Patented Surface Land pursuant to the guidelines established by the Bureau of Land Management for reclamation on federal surface. Caliche to be placed only in selected areas.

9. YEC agrees to indemnify Hoyle from damage to life or property arising from use or occupancy or production by YEC on Patented Surface Land.

10 YEC shall undertake all reasonable precautions in the drilling of wells in Sections 19 and 30, T-24-S, R-24-E to prevent damage to Hoyle's existing livestock wells located in NE¼ of Section 20 and SE¼ of Section 19 and SW¼ of Section 25. In the event YEC's petroleum operations result in damage to the ability of said water wells to produce at their customary, demonstrated levels, YEC shall promptly either (i) rework the water well(s) to restore production or (ii) drill the necessary replacement well(s) to provide the same amount of water.

11. Should any problem or disbute arise under the terms stated herein, Hoyle and YEC shall enter into negotiations to implement whatever action may be necessary to remedy said matter.

Signed for Identification:

Mona Hoyle
MONA HOYLE, his wife

Bill Hoyle
BILL HOYLE

Subscribed and sworn to before me this 5th day of ~~November~~ December, 1990 by Bill Hoyle and Mona Hoyle, his wife.

G-22

My Commission Expires:
6-30-92

THELMA BURRIS
Notary Public
State of Texas
My commission expires 06-30

Thelma Burris
Notary Public

STATE OF NEW MEXICO, County of Eddy, ss. I hereby certify that this instrument was filed for record on the
December A.D. 19 90 at 1:44 o'clock P. M.. and duly recorded

GLOSSARY

BLM LIBRARY
RS 150A BLDG. 50
DENVER FEDERAL CENTER
P.O. BOX 25047
DENVER, CO 80225

GLOSSARY

Alluvial - Pertaining to material that is transported and deposited by running water.

Annulus - Also called annular space: The space around a pipe in a wellbore, the outer wall of which may be the wall of either the borehole or the casing.

Anticline - A fold, generally convex upward, whose core contains the stratigraphically older rocks.

APD - Application for Permit to Drill.

Aquifer - A water-bearing bed or sratum of permeable rock, sand or gravel capable of yielding considerable quantities of water to wells or springs.

Areas of Critical Environmental Concern (ACEC) - Areas within the public lands where special management attention is needed to protect and prevent irreparable damage to important resource values (wildlife, historic, scenic cultural, etc.) or other natural systems or processes, or to protect humans from natural hazards.

bcf - Abbreviation for billion cubic feet. Used as a measurement of natural gas production.

Borehole - The wellbore; the hole made by drilling or boring.

Carbonate - A sediment formed of the carbonates of calcium, magnesium, and/or iron, e.g. limestone and dolomite.

Casing - steel pipe placed in an oil or gas well as drilling progresses to prevent the wall of the hole from caving in during drilling, to prevent seepage of fluids, and to provide a means of extracting petroleum if the well is productive,

Cave - Any naturally occurring void, cavity, recess or system of interconnected passages which occurs beneath the surface of the earth or within a cliff or ledge (including any cave resource therein, but not including any vug, mine, tunnel, aqueduct or other manmade excavation) and which is large enough to permit an individual to enter, whether or not the entrance is naturally formed or manmade. Such term shall include any natural pit, sinkhole or other feature which is an extension of the entrance.

Cave resource - Any material of substance occurring naturally in caves on federal lands, such as animal and plant life, paleontological deposits, sediments, minerals, speleogens and speleothems.

Christmas tree - The control valves, pressure gauges and chokes assembled at the top of a well to control the flow of oil and gas after the well has been drilled and completed.

Clastic - Pertaining to a rock or sediment composed principally of fragments derived from pre-existing rocks or minerals and transported some distance from their places of origin; also said of the texture of such a rock.

Directional drilling - intentional deviation of a wellbore from the vertical.

Diversity - The relative degree of abundance of wildlife species, plant species, communities, habitats, or habitat features per unit of area.

DST - Drill Stem Test. A test of the productive capacity of a well when still full of drilling mud. The testing tool is lowered into the hole attached to the drill pipe and placed opposite the formation to be tested. Packers are set to shut off the weight of the drilling mud, and the tool is opened to permit the flow of any formation fluid into the drill pipe, where it can be measured.

EA - Environmental Assessment.

EIS - Environmental Impact Statement

Endangered species - Federally listed: any species of animal or plant in danger of extinction throughout all or a significant portion of its range; State (Group I): species whose prospect of survival or recruitment in the state are in jeopardy in the foreseeable future; State (Group II): species whose prospect of survival or recruitment within the state may become jeopardized in the near future.

FLPMA - The Federal Land Policy and Management Act of 1976, which sets the basic land management policies of the Bureau of Land Management and mandated the BLM Wilderness review. Often referred to as the Bureau's "Organic Act" and as "Flipma."

Foot wall - The mass of rock beneath a fault, orebody, or mine working; esp. the wall rock beneath an inclined vein or fault.

Full-field development - For this document, the reasonable foreseeable development of oil and gas production in the Dark Canyon area.

FWS - U.S. Fish and Wildlife Service.

Geophysical logging - geophysical measurements using any of several electrical, acoustical or radioactive devices used to ascertain downhole geophysical information about a well.

Habitat - An area where a plant or animal lives. Sum total of environmental conditions in the area.

Hanging wall - The overlying side of an orebody, fault, or mine working; especially the rock wall above an inclined vein or fault.

Hydrogen sulfide - A toxic, corrosive gas (H_2S) with a characteristic odor of rotten eggs. It is emitted in the natural decomposition of organic matter and is present in much crude oil and natural gas.

Hydrocarbons - Any organic compound, gaseous liquid or solid consisting solely of carbon and hydrogen, such as crude oil.

Isolith - An imaginary line of equal aggregate thickness of a given lithologic type within a formation, measured perpendicular to the bedding at selected points.

Karst - An area of irregular limestone in which erosion has produced fissures, sinkholes, underground streams and caverns.

KGS - Know Geologic Structure. Area adminstratively determined to be presumptively productive for oil and gas.

Kickoff point - the depth in a vertical hole at which a deviated or slant hole is started; used in directional drilling.

Kill (a well) - Stop a well from producing by circulating water and mud to control pressures within the borehole.

Lease - A legal document executed between a landowner, as lessor, and a company or individual, as lessee, that grants the right to exploit the premises for minerals or other products.

Lineament - A linear topographic feature of regional extent that is believed to reflect crustal structure. Examples are fault lines, aligned volcanoes, and straight stream courses.

mcf - Abbreviation for thousand cubic feet. Used as a measurement of natural gas production.

Monocline - A local steepening in an otherwise uniform gentle dip.

MOU - Memorandum of Understanding.

Multiple use - The management of the various surface and subsurface resources so that they are utilized in the combination that will best suit the present and future needs of the American people.

Multiple use management - Consists of managing the public lands to meet one or more of the following objectives:
  a) domestic livestock grazing
  b) fish and wildlife development and utilization
  c) industrial development
  d) mineral production
  e) occupancy (land ownership)
  f) outdoor recreation
  g) timber production
  h) watershed protection
  i) wilderness preservation
  j) preservation of public values

Neat cement - A cement mixed with no additives other than water. Commonly referred to as "premium" cement.

NEPA - National Environmental Policy Act of 1976.

NMDGF - New Mexico Department of Game and Fish.

NMSO - BLM New Mexico State Office.

NMOCD - New Mexico Oil Conservation Division.

NOI - Notice of Intent

Normal fault - A fault in which the hanging wall appears to have moved downward relative to the foot wall. The angle of dip is usually 45-90 degrees.

Nose - A short, plunging anticline without closure.

NSO - No surface Occupancy

Off-road vehicle (ORV) - Any motorized vehicle designed for or capable of cross-country travel in the absence of designated roads.

Packer - A piece of downhole equipment used to block the flow of fluids through the annular space between the tubing and the wall of the wellbore by sealing off the space between them.

Pennsylvanian - A period of the Paleozoic era (after the Mississippian and before the Permian), thought to have covered the span of time between 320 and 280 million year ago; also, the corresponding system of rocks.

Percolation - The downward entry of water in the soil.

Perennial Stream - A stream or portion of a stream which flows continuously.

Permeability - The capacity of a porous rock, sediment, or soil for transmitting a fluid; it is a measure of the relative ease of fluid flow under unequal pressure. The customary unit if measurement is the millidarcy.

Permian - The last period of the Paleozoic era (after the Pennsylvanian), thought to have covered the span of time between 280 and 225 million years ago; also, the corresponding system of rocks.

Point Bar - One of a series of low, arcuate ridges of sand and gravel developed on the inside of a growing meander by the slow addition of individual accretions accompanying migration of the channel toward the outer bank.

Productive horizon - zone in which product such as oil or gas occurs.

Public land - Any land and interest in land owned by the United States and administered by the Secretary of the Interior through the Bureau of Land Management, without regard to how the United States acquired ownership, except:

a) lands located on the Outer Continental Shelf
b) lands held for the benefit of Indians, Aleuts and Eskimos
c) lands in which the United States retains the subsurface m mineral rights but the surface is privately owned.

Public land laws - The body of laws regulating the administration of public lands and their resources.

Reverse fault - A fault along which the hanging wall has been raised relative to the foot wall. Partial synonym: thrust fault.

Rig - The derrick or mast, drawworks and attendant surface equipment of a drilling unit.

Right-of-way (ROW) - Authorization to use public land for a specified purpose such as roads, pipelines, powerlines, water wells and communication sites.

Riparian vegetation - Vegetation which occurs in or adjacent to drainage ways or their floodplains.

RMP - Resource Management Plan.

RNA - Research Natural Area

ROD - Record of Decision; the official published record of decisions made on and Environmental Impact Statement or Resource Management Plan.

Scat - animal fecal droppings.

Sedimentary rocks - Rocks formed by the consolidation of originally loose sediments. One of the three major rock classifications, the others being igneous and metamorphic.

Shut-in well - A well in which the inlet and outlet valves have been shut off so that it stops producing.

SMA - Special Management Area.

Soil series - A group of soils having genetic horizons (layers) that, except for the texture of the surface layer, have similar characteristics and arrangement in the profile.

Split estate - Refers to the situation where the mineral estate is owned or controlled by a party (usually, but not always, the federal government) other than the owner of the land surface in the same area.

Spud - Or "spud-in:" To begin drilling a well by moving the drill stem up and down in the hole over a short distance without rotation.

Stage tool - A multistage cementing device used for cementing more than one discreet section in the annular space behind a casing string.

Squeeze - A cementing operation in which cement is pumped behind the casing under high pressure to re-cement channelled areas or to block off an uncemented zone.

Syncline - A fold of which the core contains the stratigraphically younger rocks; it is generally concave upward.

Tag - To touch an object downhole with the drill stem, with a tubing string, or with a wireline in an effort to establish the depth of the object.

Tertiary - The first period of the Cenozoic era (after the Cretaceous of the Mesozoic era and before the Quaternary), thought to have covered the span of time between 65 million and two million years ago. Also, the corresponding system of rocks.

Thixotropic - A fluid that is in a liquid state when flowing and a semisolid gel-like state when at rest. Most drilling fluids must be thixotropic so that the cuttings in the fluid remain in suspension when circulation is stopped.

Threatened species - Any species likely to become endangered within the foreseeable future throughout all or a significant part of its range.

Tubing - Small-diameter pipe run into a well to serve as the conduit for the passage of oil and gas to the surface.

USFS - U.S. Forest Service

USGS - U.S. Geological Survey

VRM - Visual Resource Management.

Well spacing - regulation for conservation purposes of the number and location of wells over a reservoir.

Wilderness - As defined by The Wilderness Act of 1964, "A wilderness, in contrast with those areas where man and his own works dominate the landscape, is...recognized as an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain." Wilderness is an area of undeveloped federal land retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions.

Wildlife - Includes all species of mammals, birds, amphibians, reptiles, mollusks, and crustaceans or their progeny or eggs which, whether raised in captivity or not, are normally found in a wild state. Feral horse and burros, often incorrectly referred to as "wild horses and burros," are excluded from this definition.

WSA - Wilderness Study Area.

REFERENCES

REFERENCES

Asquith, G. B., with Gibson, C. R. **Basic Well Log Analysis for Geologists:** American Association of Petroleum Geologists. Tulsa, Oklahoma, 1983.

Bjorklund, L. J., and Motts, W. S. *"Geology and Water Resources of the Carlsbad area, Eddy County, New Mexico:"* **U.S. Geological Survey open-file report.** 1959.

BLM Cave and Karst Area Task Force. *"Report of the Activities of the Cave and Karst Area Task Force."* Unpublished report on file at the Carlsbad Resource Area Office, Bureau of Land Management, Carlsbad, New Mexico. 1991.

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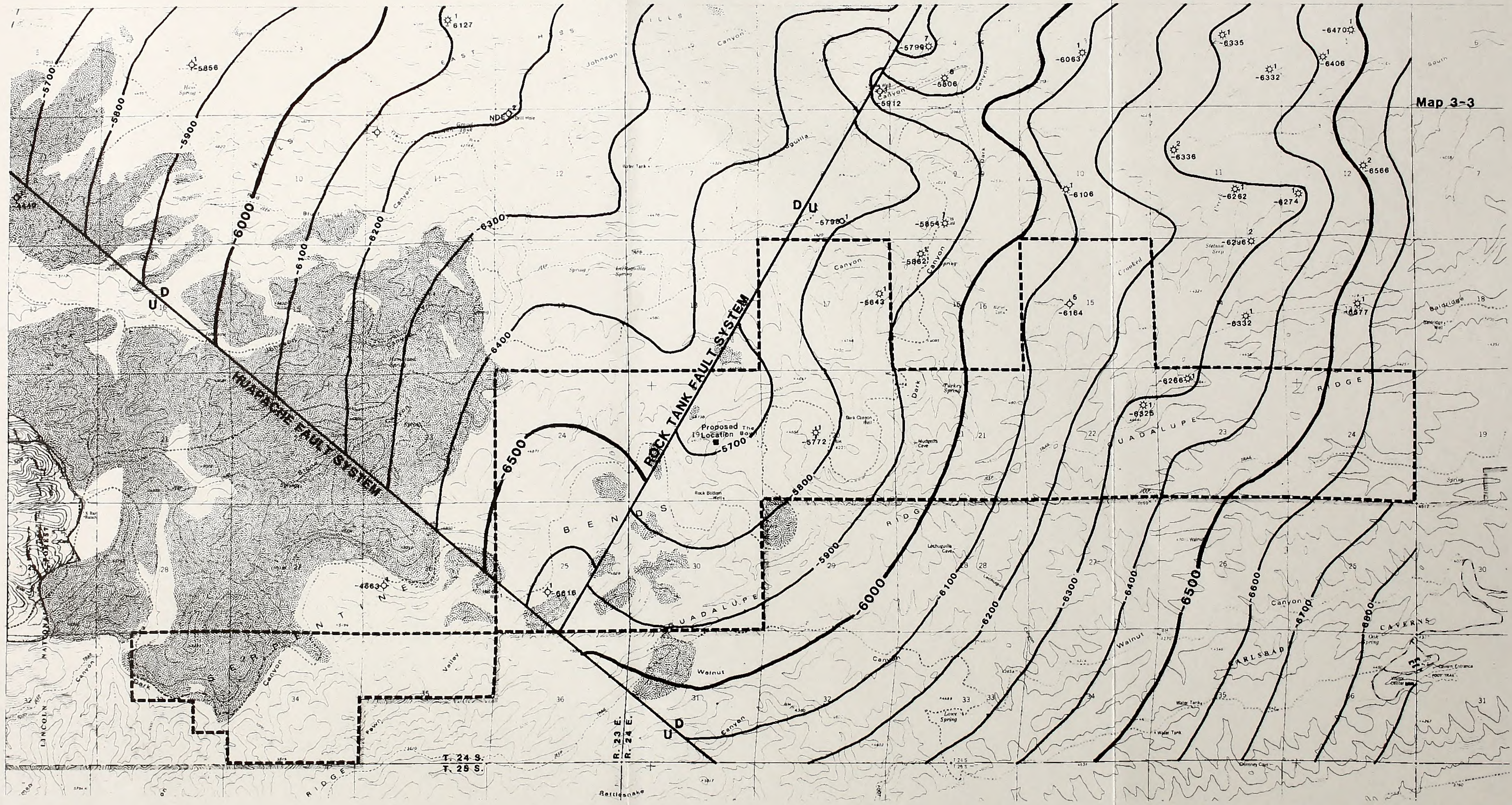
Map 3-3



STRUCTURE MAP

(Top of the Middle Morrow Formation)

SCALE 1:24 000

CONTOUR INTERVAL 100 FEET

DATUM: MEAN SEA LEVEL

(From EIS team files, 1992)

- - - - - - Dark Canyon EIS Boundary

— — — Carlsbad Caverns National Park Boundary

D/U Fault, upthrown and downthrown sides indicated

LEGEND

☼ GAS WELL

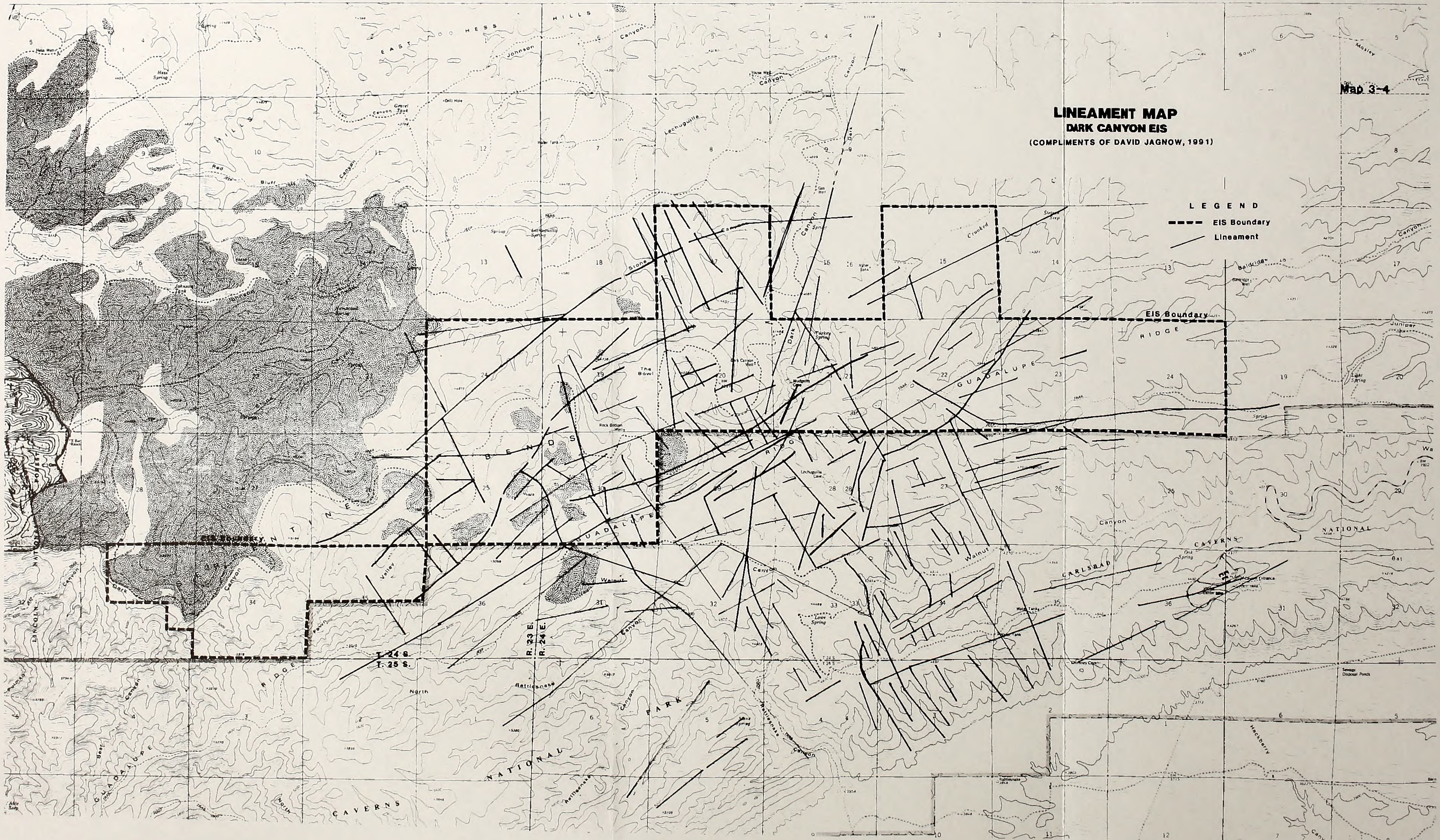
⌖ DRY AND ABANDONED WELL

☼ TEMP. ABANDONED GAS WELL

■ LOCATION

NDE: NOT DEEP ENOUGH

~ -6100 ~ ELEVATION OF MIDDLE MORROW



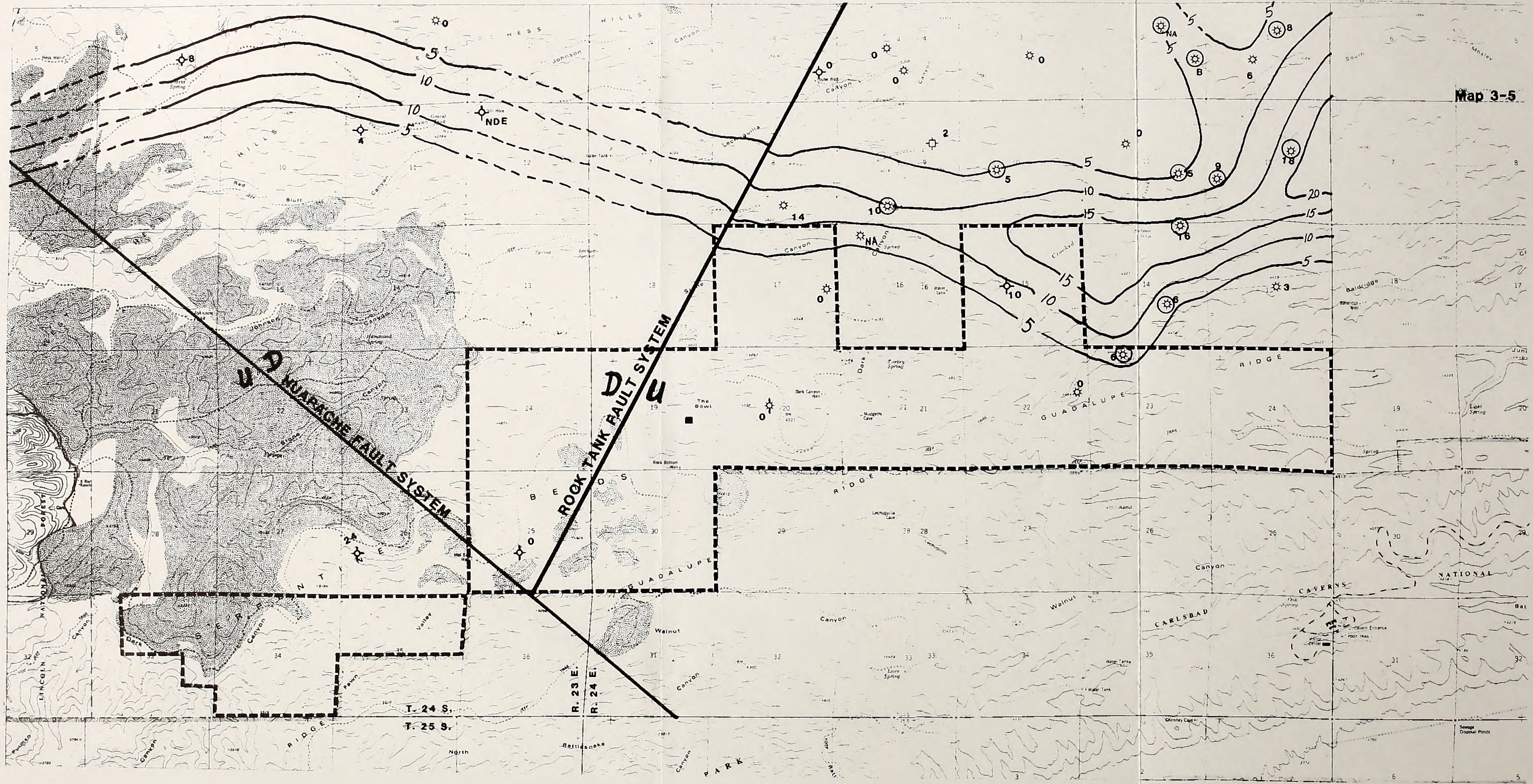
Map 3-4

LINEAMENT MAP

DARK CANYON EIS

(COMPLIMENTS OF DAVID JAGNOW, 1991)

Map 3-5



ISOLITH MAP: LOWER MORROW FORMATION

Total Sands ≤ 70 API with Neutron Density Cross-over

(From EIS team files, 1992)

- - - - - Dark Canyon EIS Boundary

— · — Carlsbad Caverns National Park Boundary

D/U Fault, upthrown and downthrown sides indicated

SCALE 1:24 000

CONTOUR INTERVAL 5 FEET

LEGEND

☼ GAS WELL

⌖ DRY AND ABANDONED WELL

☼ TEMP. ABANDONED GASWELL

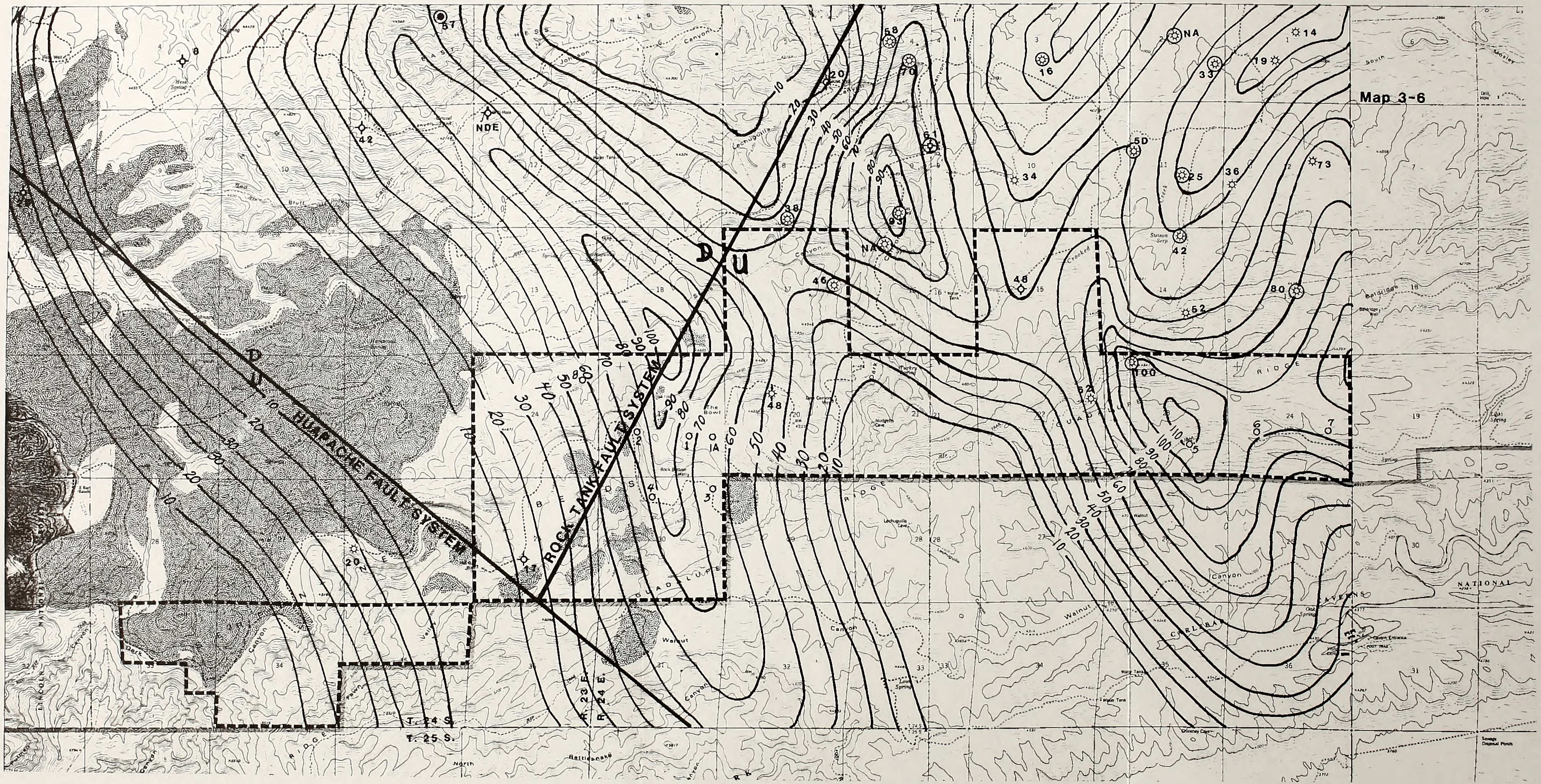
☼ ABANDONED GAS WELL

■ LOCATION

○ WELL PRODUCING (or produced) FROM LOWER MORROW SANDS.

NA: CNL LOG NOT AVAILABLE

~10~ THICKNESS IN FEET OF LOWER MORROW



- - - - - Dark Canyon EIS Boundary

━━━ Carlsbad Caverns National Park Boundary

D/U Fault, upthrown and downthrown sides indicated

ISOLITH MAP: MIDDLE MORROW FORMATION

Total Sands ≤ 70 API with Neutron Density Cross-over

(From EIS team files, 1992)

SCALE 1:24 000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 10 FEET

LEGEND

○ RFD WELL

~5D~ THICKNESS IN FEET OF MIDDLE MORROW

☼ GAS WELL

⌖ DRY AND ABANDONED WELL

☼ TEMP. ABANDONED GAS WELL

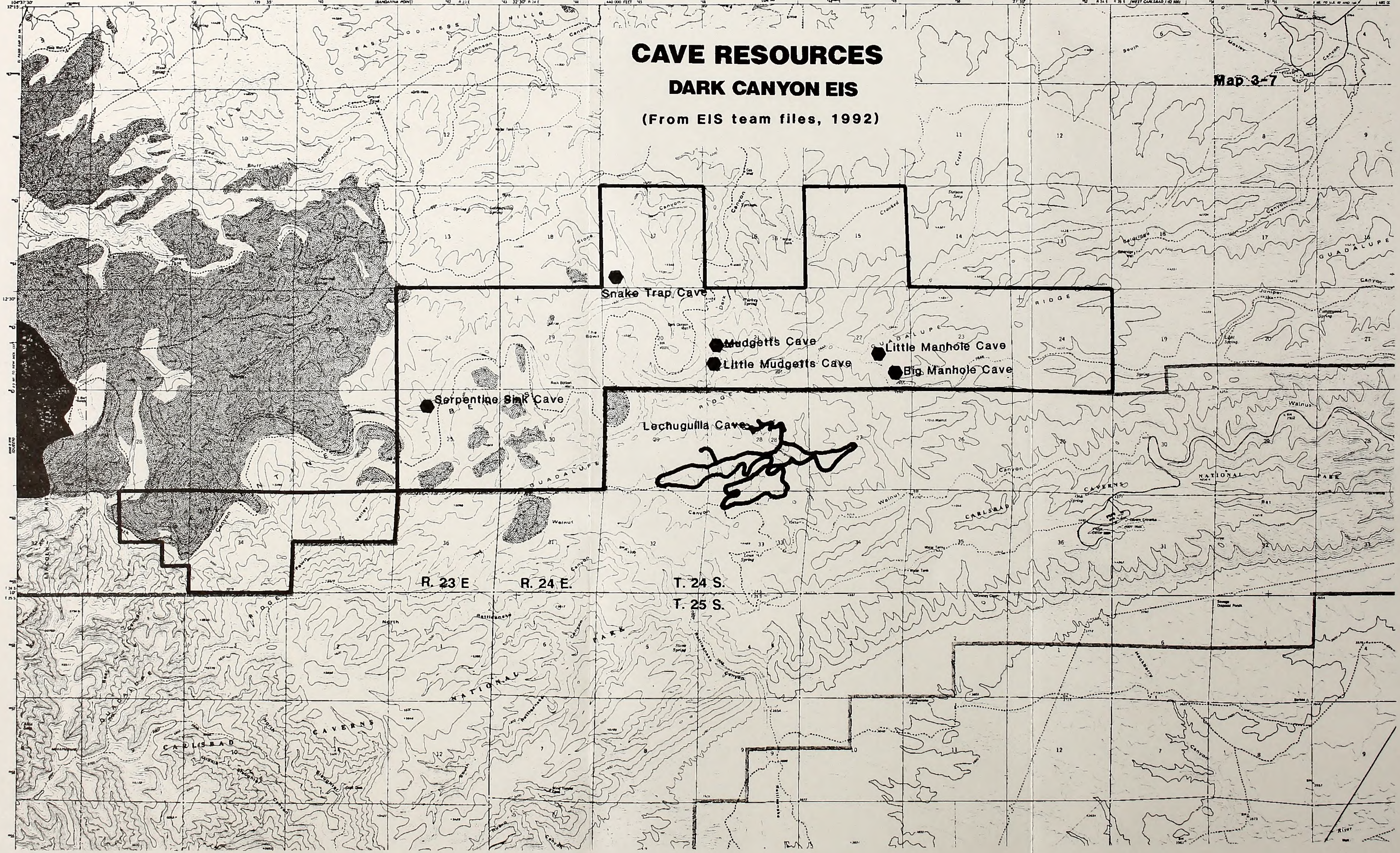
⌖ ABANDONED GAS WELL

■ LOCATION

NDE NOT DEEP ENOUGH

◯ WELL PRODUCING (or produced) FROM MIDDLE MORROW

NA CNL LOG NOT AVAILABLE



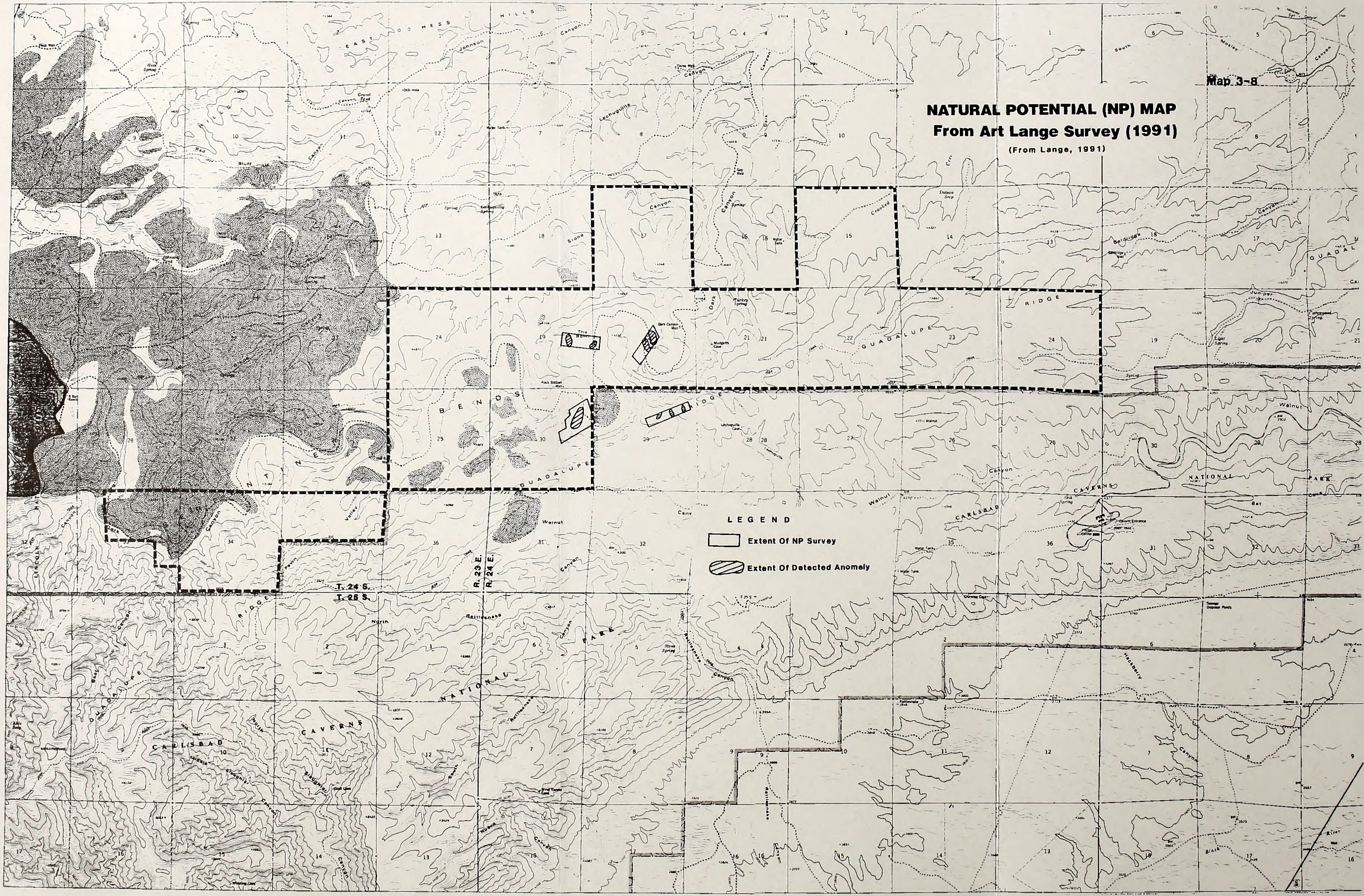
Map 3-7

CAVE RESOURCES

DARK CANYON EIS

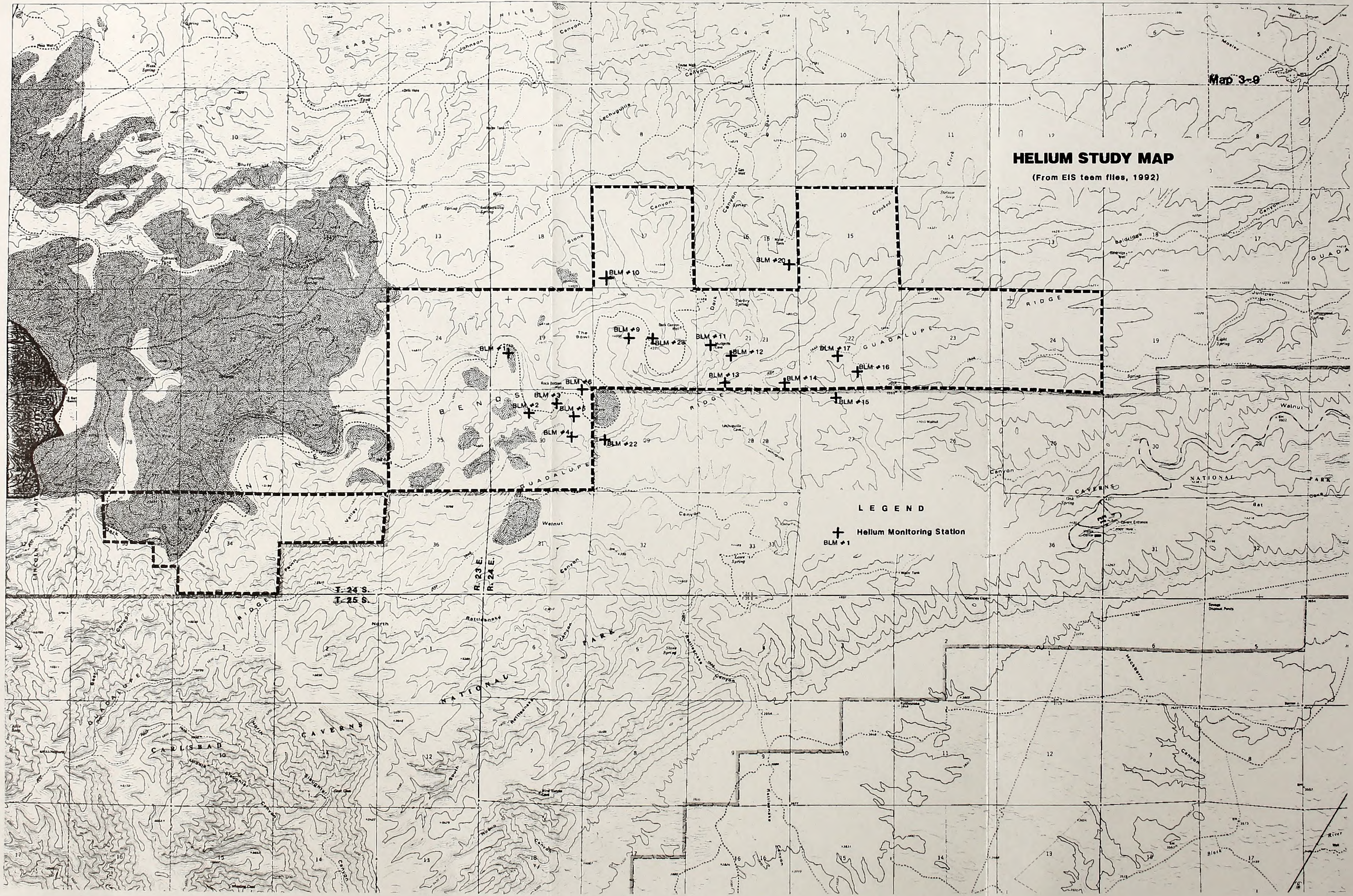
(From EIS team files, 1992)

Map 3-8



NATURAL POTENTIAL (NP) MAP From Art Lange Survey (1991)

(From Lange, 1991)



Map 3-9

HELIUM STUDY MAP

(From EIS team files, 1992)

LEGEND

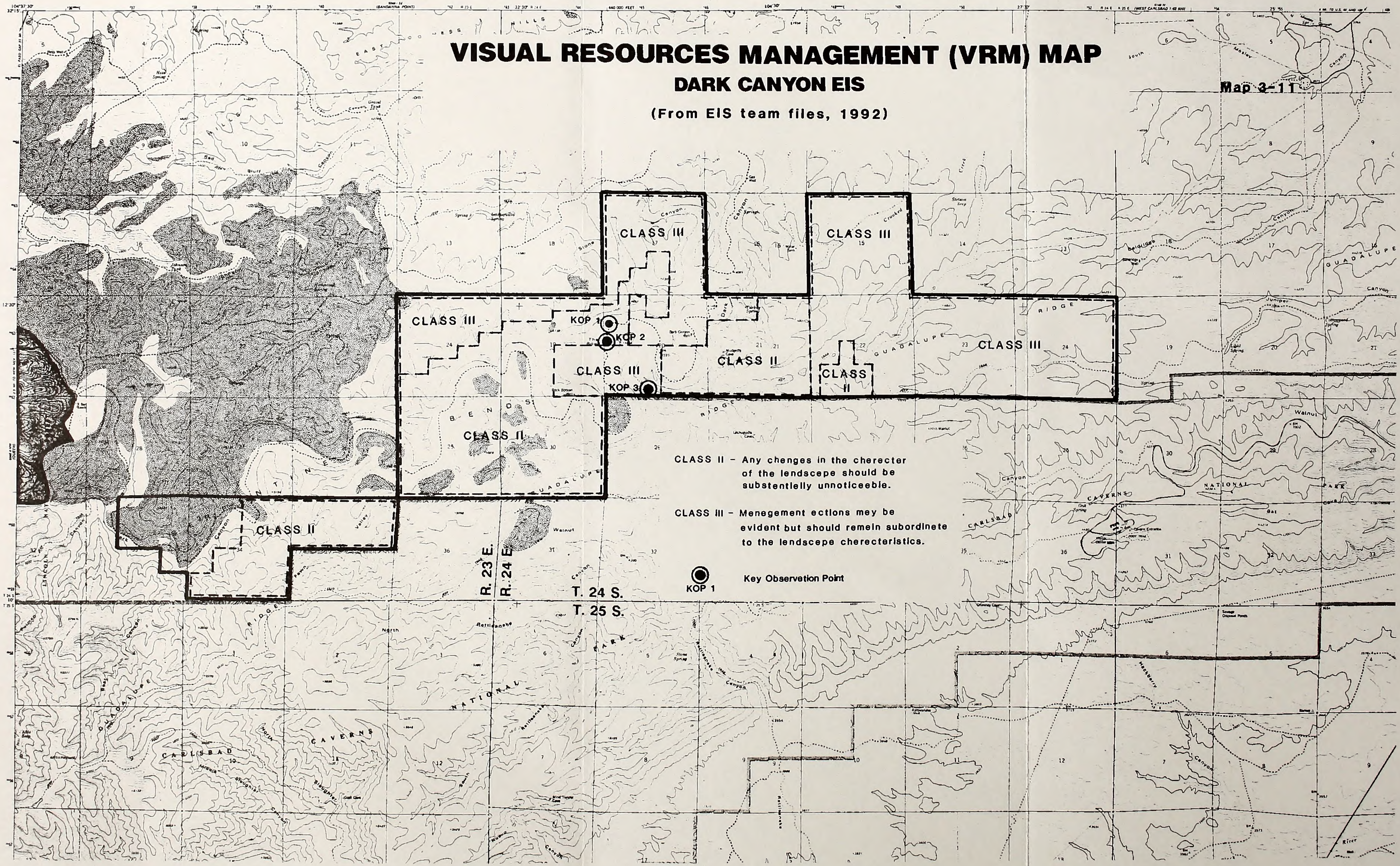
+ Helium Monitoring Station BLM #1

VISUAL RESOURCES MANAGEMENT (VRM) MAP

DARK CANYON EIS

(From EIS team files, 1992)

Map 3-11

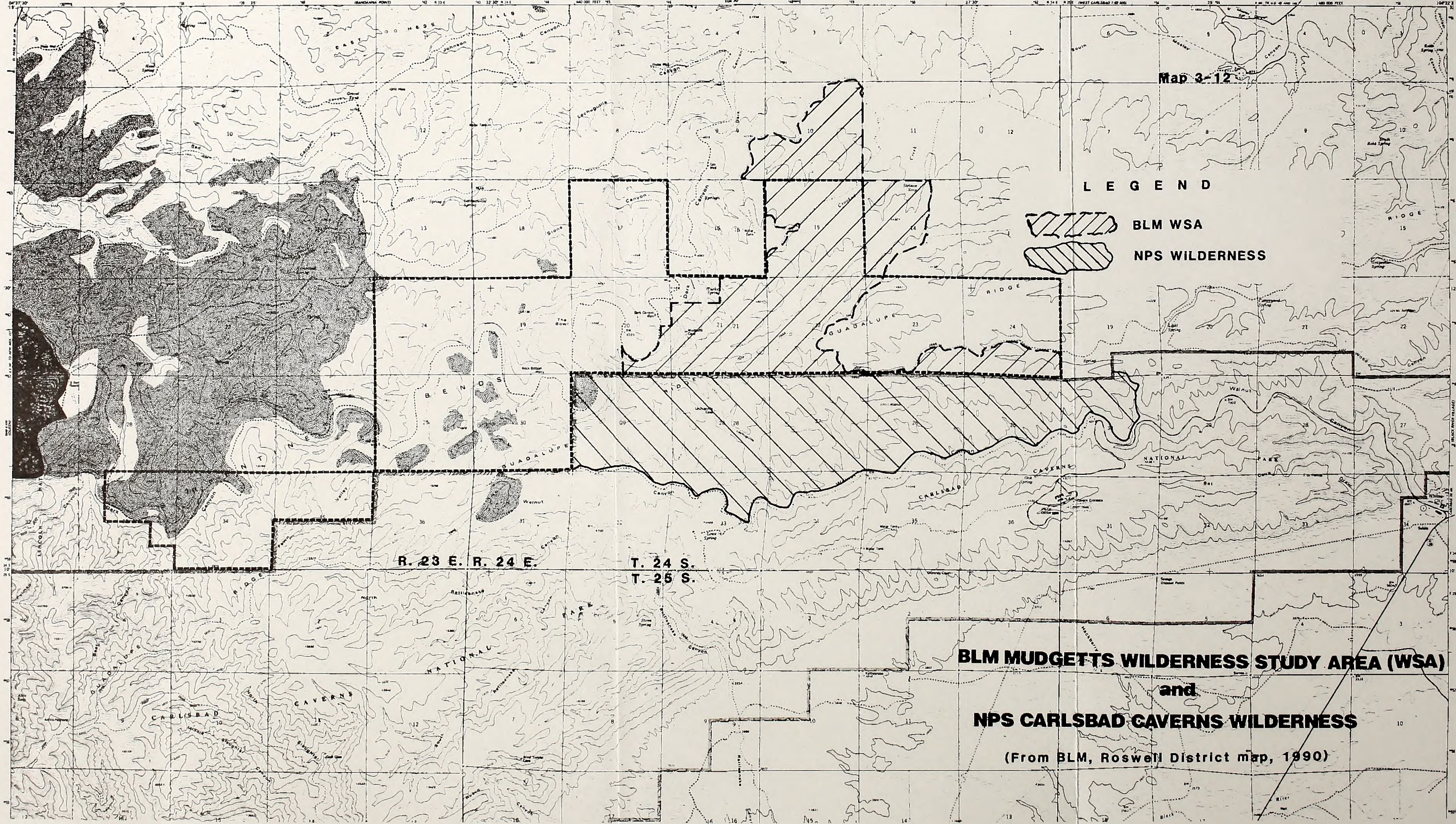


CLASS II - Any changes in the character of the landscape should be substantially unnoticeable.

CLASS III - Management actions may be evident but should remain subordinate to the landscape characteristics.

● KOP 1 Key Observation Point

Map 3-12



BLM MUDGETTS WILDERNESS STUDY AREA (WSA)
and
NPS CARLSBAD CAVERNS WILDERNESS

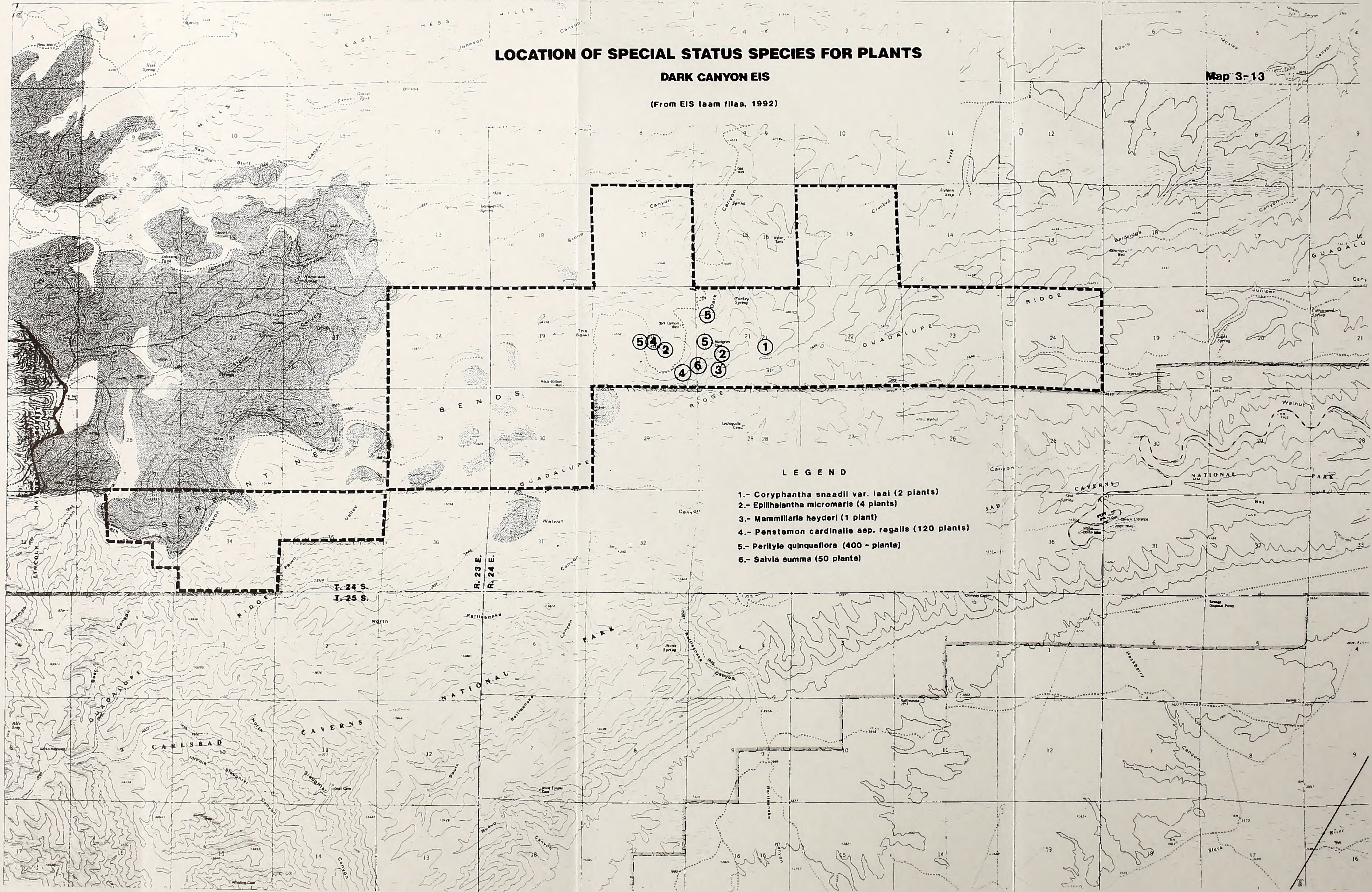
(From BLM, Roswell District map, 1990)

LOCATION OF SPECIAL STATUS SPECIES FOR PLANTS

DARK CANYON EIS

Map 3-13

(From EIS taam fllas, 1992)

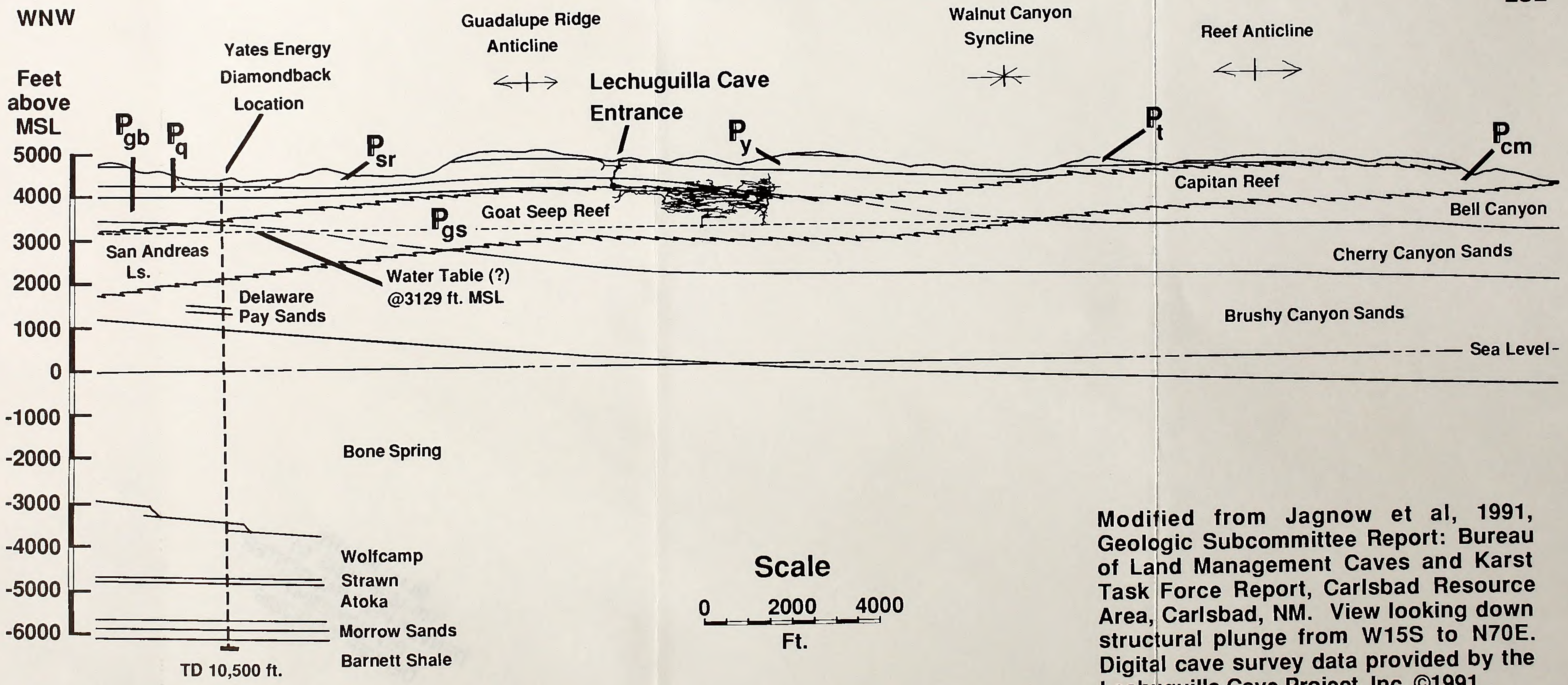


L E G E N D

1.- Coryphantha snaadil var. laai (2 plants)
2.- Epilihalantha micromaris (4 plants)
3.- Mammillaria heyderi (1 plant)
4.- Penstemon cardinalie aep. regalis (120 plants)
5.- Perityle quinqueflora (400 - planta)
6.- Saivia eumma (50 plante)

Figure 3-2

LECHUGUILLA CAVE GEOLOGIC CROSS-SECTION



Modified from Jagnow et al, 1991, Geologic Subcommittee Report: Bureau of Land Management Caves and Karst Task Force Report, Carlsbad Resource Area, Carlsbad, NM. View looking down structural plunge from W15S to N70E. Digital cave survey data provided by the Lechuguilla Cave Project, Inc. ©1991

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Dark Canyon environmental
impact statement, draft

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